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*Part 2: Metrological controls and
performance tests*

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OIML R 117-2

Dynamic Measuring Systems for Liquids other than Water
Part 2: Metrological controls and performance tests

EXPLANATORY NOTE

(This explanatory note will be deleted from R 117-2 before final publication.)

Work originally started on the effort to produce an R 117 “test methods” document in the period of 1997 – 2004. This work was led by Germany and the Netherlands. In 2004, it was decided to delay work on the test methods document until after approval and publication of R 117-1 “General Requirements.”

After publication of OIML R 117-1 in 2008, an international working group (IWG) was formed to create R 117-2. The United States serves as the chair of the IWG – with significant on-going participation from Austria, Canada, the Czech Republic, France, Germany, the Netherlands, Sweden, and the United Kingdom. The IWG has met several times over the last two years, including: April 2009 in Vienna, Austria; January 2010 in Borås, Sweden; May 2010 in Gaithersburg, USA; and November 2010 in Paris, France. In addition to the “in-person” meetings, the IWG has also held over 15 web-based meetings to continue to accelerate the work effort.

The IWG chair would like to take this opportunity to thank the IWG participants for their hard work on this document and to thank the nations that have graciously hosted the IWG meetings.

Some special notes concerning the 1CD of R 117-2:

- Because of its size and complexity, the 1CD of this document (OIML R 117-2) only covers metrological controls and performance tests for type approval. The 2nd CD will include metrological controls and performance tests for initial verification.
- After receiving international comments on the 1CD, the following items are planned to be included with the package that accompanies the 2CD of R 117-2:
 - Responses to international comments on the 1CD;
 - R 117-3 (1CD) “Format of the Test Report;”
 - Initial verification sections;
 - Annex E – Measuring Systems for Beer + Milk + other foaming potable liquids; and
 - Annex F – Pipelines + Ship Loading Systems.
- Some newly developed items in this document (R 117-2), if approved, will necessitate a minor revision of some of the corresponding “requirements” sections of R 117-1. An attempt has been made to clearly mark these items in R 117-2. The most significant of these changes include the removal of Annex A from R 117-1 (now part of Section 4 of R 117-2) and a change that makes endurance testing only relevant for meters with moving parts (Section 5.4).

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 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. OIML Member States shall implement these Recommendations to the greatest possible extent;

International Documents (OIML D), which are informative in nature and which are intended to harmonize and improve work in the field of legal metrology;

International Guides (OIML G), which are also informative in nature and which are intended to give guidelines for the application of certain requirements to legal metrology; and

International Basic Publications (OIML B), which define the operating rules of the various OIML structures and systems.

OIML Draft Recommendations, Documents and Guides are developed by Technical Committees or Subcommittees which comprise representatives from the Member States. Certain international and regional institutions also participate on a consultation basis. Cooperative agreements have been established between the OIML and certain institutions, such as ISO and the IEC, with the objective of avoiding contradictory requirements. Consequently, manufacturers and users of measuring instruments, test laboratories, etc. may simultaneously apply OIML publications and those of other institutions.

International Recommendations, Documents, Guides and Basic Publications are published in English (E) and translated into French (F) and are subject to periodic revision.

Additionally, the OIML publishes or participates in the publication of **Vocabularies (OIML V)** and periodically commissions legal metrology experts to write **Expert Reports (OIML E)**. Expert Reports are intended to provide information and advice, and are written solely from the viewpoint of their author, without the involvement of a Technical Committee or Subcommittee, nor that of the International Conference of Legal Metrology. Thus, they do not necessarily represent the views of the OIML.

This publication, OIML R 117-2, edition [????](#) (E) – was developed by the OIML Technical Subcommittee TC 8/SC 3 *Dynamic measurement of liquids other than water*. It was approved for final publication by the International Committee of Legal metrology in [????](#).

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R 117-2 Annex List	Test Procedures for Complete Measuring Systems
A	Fuel dispensers Blend dispensers Fuel dispensers for liquefied gases under pressure (LPG dispensers)
B	Measuring systems on road tankers
C	Measuring systems for the unloading of ships' tanks and for rail and road tankers using an intermediate tank
D	Measuring systems for liquefied gases under pressure (other than LPG dispensers)
E	Measuring systems for milk, beer, and other foaming potable liquids
F	Measuring systems on pipelines and systems for loading ships
G	Measuring systems intended for the refuelling of aircraft
H	Self service arrangements with fuel dispensers
I	Other self service arrangements
I	Unattended delivery

Dynamic Measuring Systems for Liquids other than Water

Part 2: *Metrological Controls and performance tests*

1 Scope

1.1 This Recommendation specifies the metrological and technical requirements applicable to dynamic measuring systems for quantities (volume or mass) of liquids other than water subject to legal metrology controls. It also provides requirements for the approval of specific components of the measuring systems (meter, flowcomputer, etc.).

1.2 In principle, this Recommendation applies to all measuring systems fitted with a meter as defined in T.m.3 (continuous measurement), whatever be the measuring principle of the meters or their application, except:

- Dynamic measuring devices and systems for cryogenic liquids (OIML R 81),
- Water meters for the metering of cold potable water and hot water (OIML R 49-1, R 49-2 and R 49-3),
- Heat meters (OIML R 75-1, R 75-2 and R 75-3).

1.3 This Recommendation is not intended to prevent the development of new technologies.

1.4 National or international regulations are expected to clearly specify which measuring systems for liquids other than water are subject to legal metrology controls. For waste water measurement, it is up to the national authorities to decide whether the use of measuring systems conforming to this Recommendation is mandatory, and which accuracy class is required.

1.5 Part 2 of this document (OIML R 117-2) specifies the metrological controls and performance tests to meet the metrological and technical requirements of OIML R 117-1 for both complete measuring systems and constituent elements of a measuring system that are approved for separate type approval.

2 Metrological control

2.1 Type approval

Measuring systems subject to legal metrology control shall be subject to type approval.

In addition, the constituent elements of a measuring system, mainly those listed below, and the sub-systems which include several of these elements (for example, a flowcomputer), are able to receive separate type approval upon the request of the manufacturer:

- meter;
 - measuring device;
 - meter sensor;
 - transducer;
 - electronic calculator;
 - indicating device;
- gas separator;
- gas extractor;
- special gas extractor;
- conversion device;
- ancillary devices providing or memorizing measurements results:
 - printing device;
 - memory device
 - self-service device;
- temperature measuring device or sensor;
- pressure measuring device or sensor;
- density measuring device or sensor.

See also Annex X.4 on “General metrological requirements for specific components of a measuring system” for a chart that shows the components that are able to receive a separate type approval cross-referenced with sections from R 117-1 that apply to each component.

Note: In some countries, the expression "type approval" can be reserved for complete measuring systems. In this case, it is advisable that types of constituent elements be submitted to a procedure similar to type approval, making it possible to certify the conformity of the type of a constituent element to the regulation.

The constituent elements of a measuring system shall comply with the relevant requirements even when they have not been subject to separate type approval (except, of course, in the case of ancillary devices and additional devices that are exempted from the controls).

Unless otherwise specified in this Recommendation, a measuring system shall fulfil the requirements without adjustment of the system or of its elements during the course of the tests. Relevant tests belonging together should be carried out on the same measuring system or element, under the same conditions and without adjustment. If, however, an adjustment has been performed or tests have been conducted with another measuring system and/or device this shall be documented and justified in the test report.

The test lab will have the ability to authorize alternative testing procedures as long as they are fully documented in the test report, the reasons for not following the regular test procedures are fully justified, and the procedures are within reasonable state-of-the-art testing practices.

2.2 Initial Verification

(This section will be added in the 2CD of R 117-2.)

3 Symbols, units and equations

In this Recommendation the following symbols, units and equations are used :

CID Calculator and indicating device
 NCU National currency unit
 EUT Equipment under test
 MPE Maximum permissible error
 RH Relative humidity

e Scale interval (L, kg) of the main indicating device
 f Frequency of pulses sent to the CID (pulses per second)
 i Number of pulses sent to the CID
 K Variable determined by the ratio Q_{\min}/Q_{\max} and the number of flowrates for accuracy testing

$$K = \left[\frac{Q_{\min}}{Q_{\max}} \right]^{\frac{1}{N_F - 1}}$$

mmq Minimum measured quantity (L or kg --- see also V_{\min})
 n_F Sequence number of a flowrate test
 N_F Number of flowrates for accuracy testing
 n_o Number of operations testing a gas extractor
 P_u Indicated unit price (NCU/L, NCU/kg)
 p_t Pressure of the liquid passing through the meter or the measurement transducer (bar)
 p_{\min} Minimum pressure of the liquid passing through the meter or the measurement transducer (bar)
 p_{\max} Maximum pressure of the liquid passing through the meter or the measurement transducer (bar)

$$Q = K^{n_F - 1} \times Q_{\max}$$

Q_s Simulated flowrate of the liquid (L/min, kg/min)
 Q Flowrate of liquid (L/min, kg/min)

Q_{\min} Minimum flowrate of liquid (L/min, kg/min)
 Q_{\max} Maximum flowrate of liquid (L/min, kg/min)
 Q_a Flowrate of air (L/min, kg/min)

t Time (s)
 T_s Temperature of the liquid in the standard capacity measure (°C)
 T_r Reference temperature of the standard capacity measure (°C)
 T_t Temperature of the liquid passing through the meter or measurement transducer (°C)

V_{\min}	Minimum measured quantity (L)
V_i	Indicated volume at metering conditions by the CID (L)
V_s	Volume indication of the standard capacity measure (L)
V_r	Volume indication of the standard capacity measure, compensated from the deviation of the reference temperature (L)
V_m	Volume at metering conditions stored by the CID if the CID is fitted with a memory device (L)
V_p	Printed volume at metering conditions if the CID is fitted with a printing device (L)
V_c	Volume at metering conditions calculated from the number of simulated pulses i and the k-factor k_f (L)
V_n	Volume at metering conditions (L) passing through the meter compensated for deviation from reference temperature of the standard capacity measure and pressure and temperature of the liquid
V_a	Volume of air (L)
M_i	Indicated mass CID (kg)
M_s	Mass indication of the weighing instrument (kg)
M_b	Mass indication of the weighing instrument, corrected for the buoyancy (kg)
M_m	Indicated mass stored by the CID if the CID is fitted with a memory device (kg)
M_p	Printed mass if the CID is fitted with a printing device (kg)
M_c	Mass calculated from the number of simulated pulses i and the k-factor k_f (kg)
k_f	k-factor, number of pulses per unit of quantity (pulses/L, pulses/kg)
α	Cubic expansion coefficient of the test liquid due to temperature ($^{\circ}\text{C}^{-1}$)
χ	Compressibility coefficient of the test liquid (bar^{-1})
β	Cubic expansion coefficient of the standard capacity measure due to temperature ($^{\circ}\text{C}^{-1}$)

Notes : For the determination of α refer to OIML R 63 or ISO 91-1 for petroleum products.

For the determination of χ refer to API Manual of Petroleum Measurements Standards Chapter 11.2.1 for petroleum products (new fuels issues, including E10)

If β is not known, the following values can be used.

Material	β ($^{\circ}\text{C}^{-1}$) (uncertainty : $5 \times 10^{-6} \text{ }^{\circ}\text{C}^{-1}$)
Borosilica glass	10×10^{-6}
Glass	27×10^{-6}
Mild steel	33×10^{-6}
Stainless steel	51×10^{-6}
Copper, Brass	53×10^{-6}
Aluminium	69×10^{-6}

P_i	Indicated price (price to pay) by the CID (NCU)
P_m	Price stored by the CID if the CID is fitted with a memory device (NCU)
P_p	Printed price if the CID is fitted with a printing device (NCU)
P_c	Calculated price (NCU)
E_{vi}	Error of indicated volume at metering conditions (%)
E_{vm}	Error of stored volume at metering conditions if the CID is fitted with a memory device (%)
E_{vp}	Error of printed volume at metering conditions if the CID is fitted with a printing device (%)
E_{va}	Error of indicated volume at metering conditions resulting of the presence of air (%)
E_{mi}	Error of indicated mass (%)
E_{mm}	Error of stored mass if the CID is fitted with a memory device (%)
E_{mp}	Error of printed mass if the CID is fitted with a printing device (%)
E_{ma}	Error of indicated mass resulting of the presence of air (%)
ε_0	Intrinsic error of the instrument at metering conditions (%)
ε_1	Intrinsic error at metering conditions obtained at the first accuracy test (%)
(2)	Intrinsic error at metering conditions obtained at the second accuracy test (%)
(3)	Intrinsic error at metering conditions obtained at the third accuracy test (%)
$E_{vi}(B)$	Error of indicated volume at metering conditions before the endurance test (%)
$E_{vi}(A)$	Error of indicated volume at metering conditions after the endurance test (%)
$E_{mi}(B)$	Error of indicated mass before the endurance test (%)
$E_{mi}(A)$	Error of indicated mass conditions after the endurance test (%)
E_{pi}	Error of indicated price (NCU)
E_{pm}	Error of stored price if the CID is fitted with a memory device (NCU)
E_{pp}	Error of printed price if the CID is fitted with a printing device (NCU)
\bar{E}	Mean value of errors (% , NCU, °C, bar)
n	Number of tests at the same condition
Q_s	$= 60 \times i / (k_f \times t)$
V_c	$= i / k_f$
M_c	$= i / k_f$
P_c	$= V_i \times P_u, M_i \times P_{uVr} = V_s \times [1 + (T_s - T_r)]$
V_n	$= V_r \times [1 + \alpha(T_t - T_s)] \times [1 - \chi p_i]$
E_{vi}	$= [(V_i - V_c) / V_c] \times 100$ V_c may be replaced by V_r or V_n , if appropriate
E_{vm}	$= [(V_m - V_c) / V_c] \times 100$ V_c may be replaced by V_r or V_n , if appropriate
E_{vp}	$= [(V_p - V_c) / V_c] \times 100$ V_c may be replaced by V_r or V_n , if appropriate
E_{va}	$= [(V_i - V_c) / V_c] \times 100$ V_c may be replaced by V_r or V_n , if appropriate
E_{mi}	$= [(M_i - M_c) / M_c] \times 100$ V_c M_c may be replaced by M_b , if appropriate
E_{mm}	$= [(M_m - M_c) / M_c] \times 100$ M_c may be replaced by M_b , if appropriate
E_{mp}	$= [(M_p - M_c) / M_c] \times 100$ M_c may be replaced by M_b , if appropriate

$$\begin{aligned}
E_{ma} &= [(M_i - M_c) / M_c] \times 100 V_c \\
E_{pi} &= P_i - P_c \\
E_{pm} &= P_m - P_c \\
E_{pp} &= P_p - P_c \\
\bar{E} &= [E(1) + E(2) + \dots + E(n)] / n \\
(v1 &= [(V_i - V_c) / V_c]1 \times 100 \text{ } V_c \text{ may be replaced by } V_r \text{ or } V_n , \text{ if} \\
\text{appropriate} & \\
(v2 &= [(V_i - V_c) / V_c]2 \times 100 \text{ } V_c \text{ may be replaced by } V_r \text{ or } V_n , \text{ if} \\
\text{appropriate} & \\
(v3 &= [(V_i - V_c) / V_c]3 \times 100 \text{ } V_c \text{ may be replaced by } V_r \text{ or } V_n , \text{ if} \\
\text{appropriate} & \\
(m1 &= [(M_i - M_c) / M_c]_1 \times 100 \quad M_c \text{ may be replaced by } M_b, \text{ if appropriate} \\
\varepsilon_{m2} &= [(M_i - M_c) / M_c]_2 \times 100 \quad M_c \text{ may be replaced by } M_b, \text{ if appropriate} \\
\varepsilon_{m3} &= [(M_i - M_c) / M_c]_3 \times 100 \quad M_c \text{ may be replaced by } M_b, \text{ if appropriate} \\
\varepsilon_0 &= [\varepsilon_1 + \varepsilon_2 + \varepsilon_3] / 3 \\
n_0 &= (0,002 \times V_s) / (0,01 \times V_{\min}) \text{ or } (0,002 \times M_s) / (0,01 \times M_{\min}) \\
\text{Range} &= \text{Maximum error - minimum error (\%, NCU)}
\end{aligned}$$

4 Type approval performance tests (mandatory)

(Note: Section 4 was developed from Annex A of R 117-1: 2007 ... As planned when R 117-1 was approved, Annex A will be removed from R 117-1. This removal will occur in the next update/revision of R 117-1 – which is planned to accompany the 2CD of R 117-2.)

4.1 General

This set of performance tests is intended to verify that the measuring system or its constituent elements operate as intended in a specified environment and under specified conditions. Each test indicates, where appropriate, the reference conditions for determining the intrinsic error.

Different kinds of tests are specified:

- Accuracy tests (including repeatability and flow disturbances tests, if applicable),
- Influence factor tests, and
- Electronic disturbance tests.

The tests specified in this Recommendation constitute minimum test procedures. Further tests may be undertaken, if necessary, to ensure compliance of the measuring system or its constituent elements with the requirements of this Recommendation.

When the effect of one influence quantity is being evaluated, all other influence quantities shall be held relatively constant, at values close to reference conditions.

More recent versions of the specific IEC and ISO standards referenced in this chapter's performance tests may be used so long as the metrological authority confirms that the more recent versions continue to agree with the testing required by this Recommendation.

Tests are ideally carried out on the complete measuring system, fitted with an indicating device, with all the ancillary devices, and with the correction device, if any. However, the meter subject to testing need not be fitted with its ancillary devices when the latter are not likely to influence the accuracy of the meter and when they have been verified separately (for example, an electronic printing device). The measuring device may also be tested alone provided that the calculator and the indicating device have been verified. The meter sensor may be tested alone provided that the transducer and the calculator with indicating device have been verified.

If this measuring device or meter sensor is intended to be connected to a calculator fitted with a correction device, the correction algorithm(s) as described by the manufacturer must be applied to the output signal of the transducer to determine its errors.

4.2 Uncertainties of measurement

When a test is conducted, the expanded uncertainty of the determination of errors on indications of volume or mass shall be less than one-fifth of the maximum permissible error applicable for that test on type approval and one-third of the maximum permissible error applicable for that test on other verifications. The estimation of expanded uncertainty is made according to the “Guide to the expression of uncertainty in measurement” (2008 edition) with $k = 2$.

4.3 Reference conditions

Ambient temperature :	15 °C to 35 °C
Relative humidity :	25 % to 75 %
Atmospheric pressure :	84 kPa to 106 kPa
Power voltage :	Nominal voltage (V_{nom})
Power frequency :	Nominal frequency (F_{nom})

During each test, the temperature shall not vary by more than 5 °C and the relative humidity shall not vary by more than 10 % within the reference range.

The test lab will have the ability to authorize different reference conditions as long as these conditions are fully documented with an explanation.

4.4 Test volumes

Some influence quantities have a constant effect on measurement results and not a proportional effect related to the measured volume. If the value of the significant fault is related to the measured volume (in order to be able to compare results obtained in different laboratories), it is necessary to perform a test on a fixed volume and flow rate, and not less than the minimum measured quantity. Furthermore, the test volume shall be in accordance with the uncertainty requirements in A.2.

4.5 Prevention of the influence of the liquid temperature on test results

Temperature tests concern the ambient temperature and not the temperature of the liquid used. It is therefore advisable to use a simulation test method such that the temperature of the liquid does not influence the test results. Testing requirements for temperature are found in Section 4.10.

4.6 Software setting / configuration

Software is a critical factor in the proper operation of an electronic meter. Therefore it must be verified that the software is configured correctly, and that the Type approval certificate includes any restriction in parameter setting/configuration.

(Note: This section needs addition consideration. The concept of this requirement will need to be repeated in the next revision of R 117-1 (Section 6.1.2, etc.) and space for the software settings/configurations/parameters will included in the R 117-3 “format of the test report.”)

4.7 Reverse flow (from OIML R 117-1 2.13.4)

Check if a reversal of the flow results in an error greater than the minimum specified quantity deviation. If so, the measuring system (in which the liquid could flow in the opposite direction) shall be provided with a non-return valve. See also flow computers section.

(Note: See Section 5 for “Testing procedures for meter sensors and measuring devices.”)

(Note: See Section 6 for “Testing Procedures for electronic calculators (that may be equipped with a conversion device), indicating devices and associated devices.”)

4.8 Influence factor tests on electronic devices

4.8.1 General

The general reference for testing requirements in 4.10 is OIML D 11 (Edition 2004)

Note: The testing requirements in 4.10 are planned to be updated to the 2011 version of D11 in the 2CD of R 117-2).

Test procedures in A.10 have been given in condensed form, for information only, and are adapted from the referenced IEC publications. Before conducting the tests, the applicable publications should be consulted.

4.8.1.1 For each performance test, typical test conditions are indicated; these conditions correspond to the climatic and mechanical environmental conditions to which measuring systems are usually exposed.

4.8.1.2 The applicant for type approval may indicate special/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 shall conduct 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.

4.8.2 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 indoor or outdoor 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 4.8.5 and 4.8.6.

4.8.3 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	-	<p>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.</p> <p>The conditions of this class may be found in continuously manned offices, certain workshops, and other rooms for special applications.</p>
H2	1	<p>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.</p> <p>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.</p>
H3	2	<p>This class applies to open locations with average climatic conditions, thus excluding polar and desert environments.</p>

4.8.4 Severity levels for mechanical tests

The following table gives a classification for the severity levels for mechanical tests:

Class	Severity level Vibration	Description
M1	-	<p>This class applies to locations with vibration of low significance</p> <ul style="list-style-type: none">• for instruments fastened to light supporting structures subject to negligible vibrations and shocks (transmitted from local blasting or pile-driving activities, slamming doors, etc.)
M2	1	<p>This class applies to locations with significant or high levels of vibration</p> <ul style="list-style-type: none">• vibration and shock transmitted from machines and passing vehicles in the vicinity or adjacent to heavy machines, conveyor belts, etc.
M3	2	<p>This class applies to locations where the level of vibration is high and very high</p> <ul style="list-style-type: none">• for instruments mounted directly on machines, conveyor belts etc.

4.8.5 Dry heat

Test method:	Dry heat (non condensing)
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of high temperature.
References:	IEC 60068-2-2 [12], IEC 60068-3-1 [16]
Test procedure in brief:	<p>The test consists of exposure of the EUT to the specified high temperature under "free air" conditions for a 2-hour period after the EUT has reached temperature stability.</p> <p>The change of temperature shall not exceed 1 °C/min during heating up and cooling down.</p> <p>The absolute humidity of the test atmosphere shall not exceed 20 g/m³.</p> <p>When testing is performed at temperatures lower than 35 °C, the relative humidity shall not exceed 50 %.</p> <p>The EUT shall be tested at the reference temperature of 20 °C after 1 hour conditioning,</p> <ul style="list-style-type: none">• at the specified high temperature, 2 hours after temperature stabilization,• after 1 hour recovery of the EUT at the reference temperature of 20 °C. <p>During tests, the EUT shall be in operation. Simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities:	One of the following severity levels shall be specified:					
	1	2	3	4	5	unit
	30	40	55	70	85	°C

Maximum allowable variations:	<p>All functions shall operate as designed.</p> <p>All errors shall be within the maximum permissible errors.</p>
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4.8.6 Cold

Test method: Cold

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of low temperature.

References: IEC 60068-2-1 [11], IEC 60068-3-1 [16]

Test procedure in brief: The test consists of exposure of EUT to the specified low temperature under "free air" conditions for a 2-hour period after the EUT has reached temperature stability. The EUT shall be tested:

- at the reference temperature of 20 °C after 1 hour conditioning,
- at the specified low temperature, 2 hours after temperature stabilization,
- after 1 hour recovery of the EUT at the reference temperature of 20 °C.

During tests, the EUT shall be in operation, simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.

Test severities:	One of the following severity levels shall be specified				
	1	2	3	4	unit
	5	– 10	– 25	– 40	°C

Maximum allowable variations:

- All functions shall operate as designed.
- All errors shall be within the maximum permissible errors.

4.8.7 Damp heat, cyclic (condensing)

Test method: Damp heat, cyclic (condensing)

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of high humidity when combined with cyclic temperature changes.
This test is applicable only for outdoor equipment.

References: IEC 60068-2-30 [13], IEC 60068-3-4 [17]

Test procedure in brief: The test consists of exposure of the EUT to cyclic temperature variations between 25 °C and the appropriate upper temperature, maintaining the relative humidity above 95 % during the temperature changes and during the phases at low temperature, and at 93 % at the upper temperature phases. Condensation should occur on the EUT during the temperature rise.

A 24 h cycle consists of:

- temperature rise during 3 h
- temperature maintained at upper value until 12 h from the start of the cycle
- 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
- 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 approximately at their final temperature.

The power supply is not on when the influence factor is applied.

After the application of the influence factor and recovery the EUT shall be tested at a minimum of one flow rate. During tests, the EUT shall be in operation. Simulated inputs are permitted.

Test severities:	One of the following severity levels shall be specified:		Unit
Severity levels	1	2	
Upper temperature	40	55	°C
Duration	2	2	cycles

Maximum allowable variations:

After the application of the influence factor and recovery:

- all functions shall operate as designed, and
- all errors shall be within the maximum permissible errors.

4.8.8 Vibration (random)

Test method:	Random vibration
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of random vibration.
References:	IEC 60068-2-47 [14] - IEC 60068-2-64 [15]
Test procedure in brief:	<p>The EUT shall, in turn, be tested in three, mutually perpendicular axes, mounted on a rigid fixture by its normal mounting means.</p> <p>The EUT shall normally be mounted so that the gravitational force acts in the same direction as it would in normal use.</p> <p>The power supply is not on when the influence factor is applied. After the application of the influence factor, the EUT shall be tested at a minimum of one flow rate.</p>

Test severities:	One of the following severity levels shall be specified:	
	1	2
Total frequency range	10–150 Hz	10–150 Hz
Total RMS level	$1.6 \text{ m}\cdot\text{s}^{-2}$	$7 \text{ m}\cdot\text{s}^{-2}$
ASD level 10–20 Hz	$0.05 \text{ m}\cdot\text{s}^{-3}$	$1 \text{ m}\cdot\text{s}^{-3}$
ASD level 20–150 Hz	– 3 dB/octave	– 3 dB/octave
Number of axes	3	3
Duration per axis	2 minutes	2 minutes

Maximum allowable variations:	<p>After the application of the influence factor :</p> <ul style="list-style-type: none">• all functions shall operate as designed and• all errors shall be within the maximum permissible errors.
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4.9 Electrical disturbance tests

4.9.1 General

The general reference for testing requirements in A.11 is OIML D 11 (Edition 2004). Test procedures in A.11 have been given in condensed form, for information only, and are adapted from the referenced IEC publications. Before conducting the tests, the applicable publications should be consulted.

4.9.1.1 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 environments (<i>as described in IEC EN 61000-6-1 which provides the criteria for this IEC testing</i>).
E2	This class applies to instruments used in locations with electromagnetic disturbances corresponding to those likely to be found in heavy industrial environments (<i>as described in IEC EN 61000-6-2 which provides the criteria for this IEC testing</i>).

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

Severity level for class		Test	
E1	E2	Section	Description
1	1	4.9.2.1	AC mains voltage variation
NA	NA	4.9.2.2	DC mains voltage variation
2	3	4.9.3	AC mains power – voltage dips, short interruptions, and voltage variations
2	3	4.9.4	Bursts (transients) on AC and DC mains
3	3	4.9.5	Electrostatic discharge (ESD)
2	3	4.9.6	Fast transients/bursts on signal, data and control lines
2	2	4.9.7	Surges on signal, data and control lines
NA	1	4.9.8	DC mains power – voltage dips, short interruptions and voltage variations
NA	1	4.9.9	Ripple on DC input power ports
3	3	4.9.10	Surges on AC and DC mains lines
2	3	4.9.11.1	Radiated radio frequency electromagnetic fields of general origin
3	3	4.9.11.2	Radiated radio frequency electromagnetic fields (digital radio telephones)
2	3	4.9.11.3	Conducted disturbances, induced by radio-frequency fields

4.9.1.2 Electronic devices powered by batteries

There is a distinction between the tests for instruments powered by:

- (a) Disposable batteries;
- (b) General rechargeable batteries; and
- (c) Batteries of road vehicles.

For the case of disposable and rechargeable batteries of a general nature, no applicable standards are available.

Devices powered by non-rechargeable batteries or by rechargeable batteries that cannot be (re)charged during the operation of the measuring system, shall comply with the following requirements:

- (a) The device provided with new or fully charged batteries of the specified type shall comply with the applicable metrological requirements;
- (b) As soon as the battery voltage has dropped to a value specified by the manufacturer as the minimum value of voltage where the device complies with metrological requirements, this shall be detected and acted upon by the device in accordance with Section 4.2 of R 117-1.

For these devices, no special tests for disturbances associated with the "mains" power have to be carried out.

Devices powered by rechargeable auxiliary batteries that are intended be (re)charged during the operation of the measuring instrument shall both:

- (a) comply with the requirements for devices powered by non-rechargeable batteries or by rechargeable batteries that cannot be (re)charged during the operation of the measuring system, with the mains power switched off; and
- (b) comply with the requirements for AC mains powered devices with the mains power switched on.

Devices powered by mains power and provided with a back-up battery for data-storage only, shall comply with the requirements for AC mains powered devices.

For electronic devices powered by the on-board battery of a road vehicle, a series of special tests for disturbances associated with the power supply are given in 4.10.

4.9.2 Mains voltage variations

4.9.2.1 AC mains voltage variation

Test method:	Variation in AC mains power voltage (single phase)
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of varying AC mains power voltage.
References:	IEC/TR3 61000-2-1 [18], IEC 61000-4-1 [20]
Test procedure in brief:	The test consists of exposure of the EUT to the specified power condition while the EUT is operating under normal atmospheric conditions. During tests, the EUT shall be in operation, simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.

Test severities	The following severity level shall be specified	
Severity level	1	
Mains voltage: 1), 2)	Lower limit	Upper limit
	$U_{\text{nom}} - 15 \%$	$U_{\text{nom}} + 10 \%$
Notes:	<p>1) This test is not applicable to equipment powered by a road vehicle battery.</p> <p>2) In the case of three phase power supply, the voltage variation shall apply for each phase successively.</p> <p>3) The values of U 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.</p>	

Maximum allowable variations:	All functions shall operate as designed. All errors shall be within the maximum permissible errors.
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4.9.2.2 DC mains voltage variation

Test method:	Variation in DC mains voltage
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of varying DC mains voltage.
References:	IEC 60654-2 [19]
Test procedure in brief:	The test consists of exposure of the EUT to the specified power supply conditions while the EUT is operating under normal atmospheric conditions. During tests, the EUT shall be in operation, simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.
Test severity:	The DC operating range as specified by the manufacturer but not less than $U_{nom} - 15 \% \leq U_{nom} \leq U_{nom} + 10 \%$
Notes:	1) This test is not applicable to equipment powered by a road vehicle battery.
Maximum allowable variations:	At supply voltage levels between upper and lower limit: All functions shall operate as designed. All errors shall be within the maximum permissible errors.

4.9.3 AC mains voltage dips, short interruptions and voltage variations

Test method:	Short time reductions in mains voltage
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of short time mains voltage reductions.
References:	IEC 61000-4-11 [26], IEC 61000-6-1 [29], IEC 61000-6-2 [30]
Test procedure in brief:	<p>A test generator suitable to reduce for a defined period of time the amplitude of the AC mains voltage is used.</p> <p>The performance of the test generator shall be verified before connecting the EUT.</p> <p>The mains voltage reductions shall be repeated ten times with an interval of at least ten seconds.</p> <p>The interruptions and reductions are repeated throughout the time necessary to perform the whole test; for this reason, more than ten interruptions and reductions may be necessary.</p> <p>During tests, the EUT shall be in operation, simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities:		One of the following severity levels shall be specified								Unit
Severity levels ⁽¹⁾		2			3					
Test		Test a	Test b	Test c	Test a	Test b	Test c	Test d	Test e	
Voltage reduction	Reduction to (Dips)	0	0	70	0	0	40	70	80	%
	Duration **	0.5	1	25/ 30	0.5	1	10/ 12	25/ 30	250/ 300	cycles
Notes:		1) This test is only applicable to equipment powered by AC mains supply. 2) ** These duration values are for 50 Hz / 60 Hz, respectively.								

Maximum allowable variations:	<p>a) for interruptible measuring systems, either significant faults do not occur or checking facilities detect a malfunctioning and act upon in it accordance with 4.3 when significant faults occur.</p> <p>b) for non-interruptible measuring systems, no significant faults occur.</p>
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4.9.4 Bursts (transients) on AC and DC mains

Test method:	Electrical bursts
Object of the test:	<p>To verify compliance with the provisions in 4.1.1 under conditions where electrical bursts are superimposed on the mains voltage.</p> <p>This test is not applicable to instruments connected to road vehicle batteries; see A.12 for specific testing requirements on these instruments.</p>
References:	IEC 61000-4-4 [23], IEC 61000-4-1 [20], IEC 61000-6-1 [29], IEC 61000-6-2 [30]
Test procedure in brief:	<p>A burst generator shall be used with the performance characteristics as specified in the referenced standard.</p> <p>The test consists of exposure of the EUT to bursts of voltage spikes for which the repetition frequency of the impulses and peak values of the output voltage on 50 Ω and 1000 Ω load are defined in the referenced standard.</p> <p>The characteristics of the generator shall be verified before connecting the EUT.</p> <p>At least 10 positive and negative randomly phased bursts shall be applied.</p> <p>The injection network on the mains shall contain blocking filters to prevent the burst energy from being dissipated in the mains.</p> <p>The bursts are applied during all the time necessary to perform the test; therefore, more bursts than indicated above may be necessary.</p> <p>During tests, the EUT shall be in operation (simulated inputs are permitted). Tests shall be performed at a minimum of one flow rate.</p>

Test severities:		One of the following severity levels shall be specified:		Unit
Severity levels		2	3	
Amplitude (peak value)	Supply lines	1	2	kV
Notes:		1) Tests on supply lines apply only for instruments powered by AC or DC mains power supply.		

Maximum allowable variations:	<p>a) for interruptible measuring systems, either significant faults do not occur or checking facilities detect a malfunctioning and act upon it accordance with 4.3 when significant faults occur.</p> <p>b) for non-interruptible measuring systems, no significant faults occur.</p>
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4.9.5 Electrostatic discharge

Test method:	Electrostatic discharge (ESD)
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of direct and indirect electrostatic discharges.
References:	IEC 61000-4-2 [21], IEC 61000-6-1 [29], IEC 61000-6-2 [30]
Test procedure in brief:	<p>The test comprises exposure of the EUT to electrical discharges.</p> <p>An ESD generator as defined in the referenced standard shall be used and the test set-up shall comply the dimensions, materials used and conditions as specified in the referenced standard. Before starting the tests, the performance of the generator shall be verified. At least 10 discharges per preselected discharge location shall be applied. The time interval between successive discharges shall be at least 1 second.</p> <p>For EUT not equipped with a ground terminal, the EUT shall be fully discharged between discharges.</p> <p>If the EUT is an integrating instrument, the test pulses shall be applied continuously during the measurement time.</p> <p>Contact discharge is the preferred test method. Air discharge is far less defined and reproducible and therefore shall be used only where contact discharge cannot be applied.</p> <p>Direct application:</p> <p>In the contact discharge mode to be carried out on conductive surfaces, the electrode shall be in contact with the EUT before activation of the discharge. In such case, the discharge spark occurs in the vacuum relays of the contact discharge tip.</p> <p>On insulated surfaces only, the air discharge mode can be applied. The EUT is approached by the charged electrode until a spark discharge occurs.</p> <p>Indirect application:</p> <p>The discharges are applied in the contact mode only on coupling planes mounted in the vicinity of the EUT.</p> <p>During tests, the EUT shall be in operation; simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

		The following severity level shall be specified:	Unit
Severity level:		3	
Test voltage	Contact discharge	6	kV
	Air discharge	8	kV

Maximum allowable variations:

a) for interruptible measuring systems, either significant faults do not occur or checking facilities detect a malfunction and act upon in it accordance with 4.3 when significant faults occur.

b) for non-interruptible measuring systems, no significant faults occur.

4.9.6 Fast transients / bursts on signal, data and control lines

Test method:	Electrical fast transients/bursts
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions where electrical bursts are superimposed on input/output and communication ports.
References:	IEC 61000-4-4 [23], IEC 61000-4-1 [20], IEC 61000-6-1 [29], IEC 61000-6-2 [30]
Test procedure in brief:	<p>A burst generator shall be used with the performance characteristics as specified in the referenced standard.</p> <p>The test consists of exposure to bursts of voltage spikes for which the repetition frequency of the impulses and peak values of the output voltage on 50 Ω and 1000 Ω load are defined in the referenced standard.</p> <p>The characteristics of the generator shall be verified before connecting the EUT.</p> <p>Both positive and negative polarity of the bursts shall be applied.</p> <p>The duration of the test shall not be less than 1 minute for each amplitude and polarity.</p> <p>For the coupling of the bursts into the input/output and communication lines, a capacitive coupling clamp as defined in the standard shall be used.</p> <p>The bursts are applied during all the time necessary to perform the test; for that purpose more bursts than indicated above may be necessary.</p> <p>During tests, the EUT shall be in operation and simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities	One of the following severity levels shall be specified:		Unit
Severity levels	2	3	
Amplitude (peak value)	0.5	1	kV
Notes:	<p>1) Tests on signal lines are applicable only for I/O signal, data and control ports, with a cable length exceeding 3 m (as specified by the manufacturer).</p> <p>2) This test is not applicable to equipment powered by a road vehicle battery.</p>		

Maximum allowable variations:

a) for interruptible measuring systems,
either significant faults do not occur or checking facilities detect a malfunctioning and act upon in it accordance with 4.3 when significant faults occur.

b) for non-interruptible measuring systems,
no significant faults occur.

4.9.7 Surges on signal, data and control lines

Test method:	Electrical surges on signal, data and control lines
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions where electrical surges are superimposed on input/output and communication ports.
References:	IEC 61000-4-5 [24], IEC 61000-6-1 [29], IEC 61000-6-2 [30]
Test procedure in brief:	<p>A surge generator shall be used with the performance characteristics as specified in the referenced 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 referenced standard.</p> <p>The characteristics of the generator shall be verified before connecting the EUT.</p> <p>On signal, control and data lines at least 3 positive and 3 negative surges shall be applied.</p> <p>The injection network depends on the lines the surge is coupled into and is defined in the referenced standard.</p> <p>The surges are applied during all the time necessary to perform the test; to that purpose more surges than indicated above may be necessary.</p> <p>During tests, the EUT shall be in operation; simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

		The following severity level shall be specified:	Unit
Severity level (Installation class)		2	
Unsymmetrical (Unbalanced) lines	Line to line	0.5	kV
	Line to ground	1.0	kV
Symmetrical (Balanced) lines	Line to line	NA	kV
	Line to ground	1.0	kV
Shielded I/O and Communications lines	Line to line	NA	kV
	Line to ground	0.5	kV
Notes:		<p>1. Test on signal lines apply only for I/O, signal, data and control ports, with a cable length exceeding 30 m (as specified by the manufacturer).</p> <p>2. Indoor DC signal, data, and control cables (regardless of length) are exempt from this test.</p> <p>3. This test is not applicable to equipment powered by a road vehicle battery.</p>	

Maximum allowable variations:

a) For interruptible measuring systems, either significant faults do not occur or checking facilities detect a malfunctioning and act upon in it accordance with 4.3 when significant faults occur.

b) For non-interruptible measuring systems, no significant faults occur.

In either a) or b) above, human intervention is permitted to put the EUT into operation after the test (e.g. replacing a fuse), provided that all relevant data is available after the human intervention.

4.9.8 Voltage dips, short interruptions and voltage variations on DC mains power

Test method: Voltage dips, short interruptions and voltage variations on DC input power ports.

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of voltage dips, voltage variations and short interruptions on DC input power ports.

References: IEC 61000-4-29 [28]

Test procedure in brief: A test generator as defined in the referenced 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 three dips/interruptions with intervals of 10 seconds minimum between each test event.

The EUT shall be tested for each of the specified voltage variations, three times at 10 second intervals in the most representative operating modes.

The disturbances are applied during all the time necessary to perform the test; to that purpose more disturbances than indicated above may be necessary.

During tests, the EUT shall be in operation; simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.

Test severities:		The following severity level shall be specified:	Unit
Voltage dips	Severity level	1 (test applicable only to E2 environments)	
	Test levels	40 and 70	% of the rated voltage
	Duration	0.1	s
Short interruptions	Test condition	High impedance and/or low impedance	
	Test levels	0	% of the rated voltage
	Duration	0.01	s
Voltage variations	Severity level	1	

	Test level	85 and 120	% of the rated voltage
	Duration	10	s
Notes:		1) 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. 2) This test is only applicable to equipment powered by DC mains supply and is not applicable to equipment powered by a road vehicle battery.	

Maximum allowable variations:

a) for interruptible measuring systems,
either significant faults do not occur or checking facilities detect a malfunctioning and act upon it accordance with 4.3 when significant faults occur.

b) for non-interruptible measuring systems,
no significant faults occur.

4.9.9 Ripple on DC input power ports

Test method:	Ripple on DC input power ports.
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of ripple on the low voltage DC power ports. This test does not apply to instruments connected to battery charger systems incorporating switch mode converters.
References:	IEC 61000-4-17 [27]
Test procedure in brief:	<p>A test generator as defined in the referenced standard shall be used. Before starting the tests, the performance of the generator shall be verified.</p> <p>The test consists in subjecting electrical and electronic instruments 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.</p> <p>The test shall be applied for at least 10 min or for the time period necessary to allow a complete verification of the EUT's operating performance.</p> <p>During tests, the EUT shall be in operation; simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities:	The following severity level shall be specified:
Severity level:	1
Percentage of the nominal DC voltage ⁽¹⁾	2 ⁽¹⁾
Notes:	<p>1) The test level is a peak-to-peak voltage expressed as a percentage of the nominal DC voltage, U_{DC}.</p> <p>2) This test is only applicable to equipment powered by DC mains supply and is not applicable to equipment powered by a road vehicle battery.</p>

Maximum allowable variations:	<p>a) for interruptible measuring systems, either significant faults do not occur or checking facilities detect a malfunctioning and act upon in it accordance with 4.3 when significant faults occur.</p> <p>b) for non-interruptible measuring systems, no significant faults occur.</p>
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4.9.10 Surges on AC and DC mains lines

Test method:	Electrical surges on AC and DC mains power lines
Object of the test:	<p>To verify compliance with the provisions in 4.1.1 under conditions where electrical surges are superimposed on the mains voltage.</p> <p>This test is not applicable to instruments connected to road vehicle batteries (see A.12 for specific testing requirements for these instruments).</p> <p>This test is not applicable to indoor DC power supply networks.</p>
References:	IEC 61000-4-5 [24], IEC 61000-6-1 [29], IEC 61000-6-2 [30]
Test procedure in brief:	<p>A surge generator shall be used with the performance characteristics as specified in the referenced standard IEC 61000-4-5. 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 referenced standard. The characteristics of the generator shall be verified before connecting the EUT.</p> <p>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 mains supply lines, at least 3 positive and 3 negative surges shall be applied asynchronously. The injection network depends on the lines the surge is coupled into and is defined in the referenced standard.</p> <p>The surges are applied during all the time necessary to perform the test; to that purpose more surges than indicated above may be necessary.</p> <p>During tests, the EUT shall be in operation; simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities	The following severity level shall be specified (both E1 and E2):	Unit
Severity level (installation class)	3	
Line to line	1.0	kV
Line to ground	2.0	kV

Maximum allowable variations: a) for interruptible measuring systems, either significant faults do not occur or checking facilities detect a malfunctioning and act upon in it accordance with 4.3 when significant faults occur.

b) for non-interruptible measuring systems, no significant faults occur.

In either a) or b) above, human intervention is permitted to put the EUT in operation after the test (e.g. replacing a fuse), provided that all relevant data is available after the human intervention.

Notes:

- This test does not apply to indoor networks;
- This test does not apply to cables shorter than 30 m;
- This test does not apply to devices powered by a road vehicle battery;
- Human intervention (such as a fuse replacement) is allowed after the test;
- After the test (and any human intervention), no significant faults shall occur.

4.9.11 Radio frequency, immunity tests

4.9.11.1 Radiated, radio frequency, electromagnetic field of general origin

Test method:	Radiated electromagnetic fields
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of electromagnetic fields.
References:	IEC 61000-4-3 [22], IEC 61000-6-1 [29], IEC 61000-6-2 [30]
Test procedure in brief:	<p>The EUT shall be exposed to electromagnetic field strength as specified by the severity level and field uniformity as defined by the referenced standard IEC 61000-4-3.</p> <p>The EM field can be generated in different facilities; however, the use of this is limited by the dimensions of the EUT and the frequency range of the facility.</p> <p>The frequency ranges to be considered are swept with the modulated signal, pausing to adjust the RF signal level or to switch oscillators and antennas as necessary. Where the frequency range is swept incrementally, the step size shall not exceed 1 % of the preceding frequency value.</p> <p>The dwell time of the amplitude modulated carrier at each frequency shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0.5 seconds. The sensitive frequencies (e.g. clock frequencies) shall be analyzed separately (usually, these sensitive frequencies can be expected to be the frequencies emitted by the EUT).</p> <p>During tests, the EUT shall be in operation, and simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities:		One of the following severity levels shall be specified:		Unit
Severity levels:		2	3	
Frequency range:	26 – 800 MHz (Note 2)	3	10	V/m
	80 – 800 MHz (Note 1)			
	960 –1400 MHz	3	10	V/m
Modulation:		80 % AM, 1 kHz sine wave		
Notes:		<p>1) IEC 61000-4-3 (2006-02) only specifies test levels above 80 MHz. For frequencies in the lower range the test methods for conducted radio frequency disturbances are recommended (A.11.11.3)</p> <p>2) However, for EUT having no mains or other input port available the lower limit of radiation test should be 26 MHz, taking into account that the test specified in A.11.11.3 cannot be applied (refer to Annex F of IEC 61000-4-3). In all other cases, both A.11.11.1 and A.11.11.2 shall apply.</p>		

Maximum allowable variations:

a) for interruptible measuring systems,
either significant faults do not occur or checking facilities detect a malfunctioning and act upon in it accordance with 4.3 when significant faults occur.

b) for non-interruptible measuring systems,
no significant faults occur.

4.9.11.2 Radiated, radio frequency, electromagnetic fields specifically caused by digital telephones

Test method:	Radiated electromagnetic fields
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of electromagnetic fields.
References:	IEC 61000-4-3 [22], IEC 61000-6-1 [29], IEC 61000-6-2 [30]
Test procedure in brief:	<p>The EUT shall be exposed to electromagnetic field strength as specified by the severity level and field uniformity as defined by the referenced standard IEC 61000-4-3.</p> <p>The EM field can be generated in different facilities; however, the use of this is limited by the dimensions of the EUT and the frequency range of the facility.</p> <p>The frequency ranges to be considered are swept with the modulated signal, pausing to adjust the RF signal level or to switch oscillators and antennas as necessary. Where the frequency range is swept incrementally, the step size shall not exceed 1 % of the preceding frequency value.</p> <p>The dwell time of the amplitude modulated carrier at each frequency shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0.5 seconds. The sensitive frequencies (e.g. clock frequencies) shall be analyzed separately (usually, these sensitive frequencies can be expected to be the frequencies emitted by the EUT).</p> <p>During tests, the EUT shall be in operation, and simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities:		The following severity level shall be specified:	Unit
Severity level:		3	
Frequency range	800 – 960 MHz	10	V/m
	1400 – 2000 MHz	10	V/m
Modulation		80 % AM, 1 kHz sine wave	

Maximum allowable variations:

a) for interruptible measuring systems,
either significant faults do not occur or checking facilities detect a malfunctioning and act upon in it accordance with 4.3 when significant faults occur.

b) for non-interruptible measuring systems,
no significant faults occur.

4.9.11.3 Conducted radio frequency fields

Test method:	Conducted electromagnetic fields
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of electromagnetic fields.
References:	IEC 61000-4-6 [25], IEC 61000-6-1 [29], IEC 61000-6-2 [30]
Test procedure in brief:	<p>Radio frequency EM current, simulating the influence of EM fields shall be coupled or injected into power ports and I/O ports of the EUT using coupling/decoupling devices as defined in the referenced standard IEC 61000-4-6.</p> <p>The performance of the test equipment consisting of an RF generator, (de-)coupling devices, attenuators, etc. shall be verified.</p> <p>During tests, the EUT shall be in operation, and simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities:	One of the following severity levels shall be specified:		Unit
Severity levels:	2	3	
RF amplitude (50 Ω):	3	10	V (e.m.f.)
Frequency range:	0.15 – 80		MHz
Modulation:	80 % AM, 1 kHz sine wave		
Notes:	Test on signal lines apply only for I/O signal, data and control ports, with a cable length exceeding 3 m (as specified by the manufacturer).		

Maximum allowable variations:	<p>a) for interruptible measuring systems, either significant faults do not occur or checking facilities detect a malfunctioning and act upon in it accordance with 4.3 when significant faults occur.</p> <p>b) for non-interruptible measuring systems, no significant faults occur.</p>
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4.10 Tests for power from road vehicle battery

4.10.1 General

For electronic devices powered by the on-board battery of a road vehicle, a series of special tests for disturbances associated with the power supply are given in A.12.2 and A.12.3 of this Recommendation. These tests are based on the standards series ISO 7637 [8] [9]. In accordance with clause 4 of ISO 7637-1[8], this series of standards “provides a basis for mutual agreement between vehicle manufacturers and component suppliers, intended to assist rather than restrict them”.

Electronic devices that are designed to be mounted onboard a road vehicle can normally be mounted in any kind of vehicle. Therefore, in A.12.2 and A.12.3 of this Recommendation, only the highest severity level is indicated as the preferred level.

4.10.2 Voltage variations

Test method:	Variation in supply voltage
Object of the test:	To verify compliance with the provisions in 4.1.1 under conditions of varying battery voltage
References:	<p>The upper limits specified in this clause (16 V and 32 V) are in accordance with ISO 16750-2:2006 Road vehicles – Environmental conditions and testing for electrical and electronic equipment; Part 2: Electrical loads [10].</p> <p>The lower limits (9 V and 16 V) are in accordance with ISO 16750-2:2006 code C, respectively code F.</p> <p>For specifications of the power supply used during the test to simulate the battery, refer to ISO 7637-2 [9] clause 4.4, and clause 5.4.</p>
Test procedure:	<p>The test consists of exposure to the specified power supply condition for a period sufficient for achieving temperature stability and for performing the required measurements.</p> <p>If a standard power supply (with sufficient current capacity) is used in bench testing to simulate the battery, it is important that the low internal impedance of the battery also be simulated.</p> <p>The continuous supply source shall have an internal resistance R_i less than $0.01\ \Omega$ dc and an internal impedance $Z_i = R_i$ for frequencies less than 400 Hz.</p> <p>During tests, the EUT shall be in operation; simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities:	The following severity level shall be specified:		
Severity level:	1		
Voltage:	12 V battery	upper limit	16 V
	24 V battery	upper limit	32 V
	12 V battery	lower limit	9 V
	24 V battery	lower limit	16 V

Maximum
allowable
variations:

At supply voltage levels between upper and lower limit:

- All functions shall operate as designed.
- All errors shall be within the maximum permissible errors.

4.10.3 Electrical transient conduction along supply lines

Test method:	Electrical transient conduction along supply lines
Object of the test:	<p>To verify compliance with the provisions in R 117-1, Section 4.1.1 or under the following conditions:</p> <ul style="list-style-type: none">• transients due to a sudden interruption of current in a device connected in parallel with the device under test due to the inductance of the wiring harness (pulse 2a);• transients from DC motors acting as generators after the ignition is switched off (pulse 2b);• transients on the supply lines, which occur as a result of the switching processes (pulses 3a and 3b);• voltage reductions caused by energizing the starter-motor circuits of internal combustion engines (pulse 4)
References:	<p>ISO 7637-2 [9] § 5.6.2: Test pulse 2a + 2b § 5.6.3: Test pulse 3a + 3b § 5.6.4: Test pulse 4</p>
Test procedure in brief:	<p>The test consists of exposure to disturbances on the power supply by direct coupling on supply lines.</p> <p>During tests, the EUT shall be in operation; simulated inputs are permitted. Tests shall be performed at a minimum of one flow rate.</p>

Test severities:		The following severity level shall be specified:		
Severity levels:		4		
Test pulse 2	12 V battery	pulse 2a	U_s	+ 50 V
		pulse 2b	U_s	+ 10 V
	24 V battery	pulse 2a	U_s	+ 50 V
		pulse 2b	U_s	+ 20 V
Test pulse 3	12 V battery	pulse 3a	U_s	– 150 V
		pulse 3b	U_s	+ 100 V
	24 V battery	pulse 3a	U_s	– 200 V
		pulse 3b	U_s	+ 200 V
Test pulse 4	12 V battery		U_s	– 7 V
	24 V battery		U_s	– 16 V

Maximum allowable variations:

a) for interruptible measuring systems, either significant faults do not occur or checking facilities detect a malfunctioning and act upon in it accordance with 4.3 when significant faults occur.

b) for non-interruptible measuring systems, no significant faults occur.

5 Testing procedures for meter sensors and measuring devices

5.1 General information

The meter sensor/measuring device may be tested in either a test bench or in a measuring system. It shall be installed according to manufacturer specification (meter position(s), straight pipes, flow straightening device, minimum back pressure, software setting/configuration, warm up time, etc). Low-flow cut-off (if applicable) is set at minimum value.

[Note: see R 117-1 Section 3.1.5.4 on turbine meters and other meter types concerning zero-offset.]

Metrological stability shall be achieved before any testing is started. (See Annex X.5.1 for advice on this.)

Before conducting tests, it is necessary to evaluate the meter sensor/measuring device by using the general check-list given in R 117-3 (to be developed) and the relevant points of this check-list given in Annex X.4 (cross reference table to type approval of specific components).

In accordance with the requirements of Section 6 of OIML R 117-1, tests should be carried out at the limits of the rated operating conditions – the limits of pressure, temperature, density, and viscosity (and alcohol content for drum meters for alcohol). It is possible to reduce the number of liquids to be tested if it can be shown, through technical analysis of the metering principals, that all requirements are fulfilled for any other liquid.

Definition of Meter model: Different sizes of meter sensors/measuring transducers having family similarities in the principle of operation, construction and materials. A size is defined by the nominal size of the measuring element of the meter sensor, not the size of the pipe connection.

Meter selection – family of meters

When selecting which sizes of a family of meters to be tested, the following rules shall be considered:

- The approving authority shall declare the reasons for including and omitting particular meter sizes from testing;
- Meters which have the most extreme operating parameters within a family, shall be considered for testing (e.g. the largest flowrate range, the highest peripheral (tip) speed of moving parts, etc);
- Endurance tests shall be applied to meters where the highest wear is expected;
- All performance tests relating to influence quantities and disturbances shall be carried out on one size from a family of electronic meters;

One way of selecting sizes to test is to use Fig. 5.1. Each line represents one family, meter 1 being the smallest. The family members underlined in Fig. x are then selected for testing. The sizes not tested shall be within the range of $0.5 \times Q_{\max} \leq Q_{\max} \leq 2 \times Q_{\max}$ of the adjacent sizes.

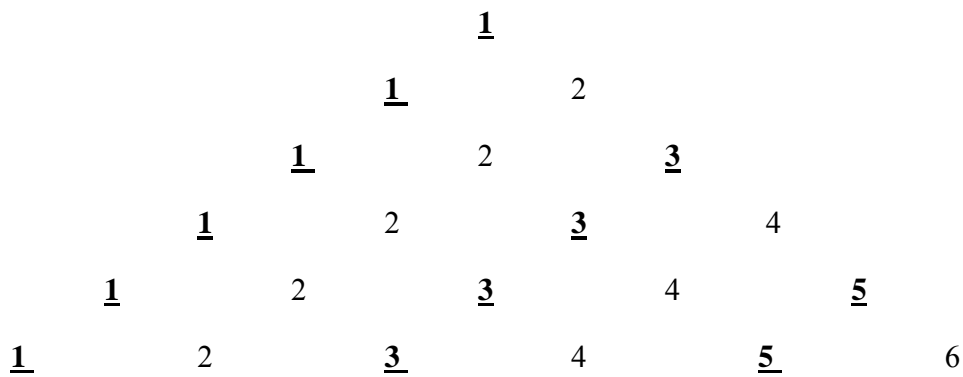


Fig. 5.1, Families of Meters Pyramid

Depending on sensor size, the tests to be carried out are as follows (the selection of sizes to be tested shall be justified and explained in the test report):

Section	Type of test	Selection of meter size to be tested
5.3.1	Reading at zero flowrate	A selection of meter sizes according to Fig 5.1 (only for turbine, electro-magnetic, ultrasonic, vortex, and massflow meters).
5.3.2	Accuracy at metering conditions	A selection of meter sizes according to Fig 5.1
5.3.3	Accuracy at limits of the working range	If documentary evidence is given that technological similarities exist between sizes, testing is conducted on a reduced number of sizes. <ul style="list-style-type: none"> • See the chart in Annex X, Section X.5.4.3
5.3.4	Flow disturbance (optional)	Only for meters sensitive to flow profile. This test is not applicable if the verification is performed at its final installation (stated in the type approval certificate). If documentary evidence is given that technological similarities exist between sizes – testing is conducted on a reduced number of sizes.
5.3.5	Inclination test, etc	Only for drum meters. All sizes.

5.4	Endurance test	<p>Only for meters with moving parts/parts under mechanical stress.</p> <p>Only for those sizes of a model for which the highest wear is expected.</p> <p>[Note: The “durability” requirement is met without this endurance test (for meters not actually tested under 5.5 because the meter will be running for more than 100 hours during all of the other tests.)]</p> <p>Note: This is a SIGNIFICANT change from the endurance requirements of R 117-1. If approved, R 117-1 will need a future revision to reflect this change.</p>
5.5	mmq	A selection of meter sizes according to Fig x (not applicable for pipeline meters).
5.6	Climate and disturbance tests	One size only in a family

5.2 Test equipment

To determine the amount of liquid passed through the meter sensor/measuring transducer, a standard test measure (OIML R120), weighing machine, pipe prover (OIML R119) or master meter can be used. Standards, instruments and methods used shall suit the purpose, be traceable to international standards or to national standards traceable to international standards and be part of a reliable calibration program. Any test methods and test volume may be used provided that it is described in the test report and is accompanied by an uncertainty statement/reference to accreditation, demonstrating that the expanded uncertainty is in accordance with Section 4.2, being smaller than 1/5 of MPE. If the uncertainty is larger than 1/5 of the MPE, a “reduced MPE” = $(\text{MPE} - \text{expanded uncertainty}) = (6/5 \times \text{MPE} - U)$ may be used. When calculating the expanded uncertainty, the resolution but not the repeatability of the EUT shall be included. (For repeatability requirements, see Section 5.4.2 and OIML R 117-1, Section 3.1.2.2.)

The volume of the supply tank shall be of sufficient capacity to not cause foaming of the liquid or a rise in temperature during the tests.

Note: It is preferable that all gas elimination devices should be vented back to the supply tank to avoid changing the test liquid specifications.

The temperature and pressure of the liquid passing through the meter sensor, measuring device or meter shall be measured close to the meter sensor/measuring device.

5.3 Accuracy

5.3.1 Indication at zero flowrate

Test for reading at zero flowrate – should not exceed line C at minimum flow rate (R 117-1 Section 3.1.5.4).

5.3.2. Accuracy at metering conditions

5.3.2.1 Accuracy at metering conditions (this section is not applicable to drum meters for alcohol, these meters are covered in 5.3.2.2)

Object of the test

The objective of this test is to verify that all individual measurement results at each flowrate meet the requirements concerning the maximum permissible errors.

General information

The flow rates of the measuring point are defined by:

$$Q = K^{n_F-1} \times Q_{\max}$$

Where n_F is a sequence number of the flow rate test, and

$$K = \left[\frac{Q_{\min}}{Q_{\max}} \right]^{\frac{1}{N_F-1}}$$

Where N_F is the number of flowrates as in the following table

Q_{\max} / Q_{\min}	N_F
5 - 9	5
10 – 12	6
13 – 21	7
22 – 35	8
36 - 60	9

Note: When testing for an expanded flow range, new test points are added outside the old flow range, without need to recalculate the old test points.

When $Q_{\max}/Q_{\min} = 10$, this gives:

$Q(1) = 1,00 \times Q_{\max}$	$(0,90 \times Q_{\max} \leq Q(1) \leq 1,00 \times Q_{\max})$
$Q(2) = 0,63 \times Q_{\max}$	$(0,56 \times Q_{\max} \leq Q(2) \leq 0,70 \times Q_{\max})$
$Q(3) = 0,40 \times Q_{\max}$	$(0,36 \times Q_{\max} \leq Q(3) \leq 0,44 \times Q_{\max})$
$Q(4) = 0,25 \times Q_{\max}$	$(0,22 \times Q_{\max} \leq Q(4) \leq 0,28 \times Q_{\max})$
$Q(5) = 0,16 \times Q_{\max}$	$(0,14 \times Q_{\max} \leq Q(5) \leq 0,18 \times Q_{\max})$
$Q(6) = 0,10 \times Q_{\max}$	$(0,10 \times Q_{\max} \leq Q(6) \leq 0,11 \times Q_{\max})$

The above table shows that the set rate of flow through the measurement transducer shall not differ by more than 10% from the calculated flow rate, furthermore the limits for the measurement transducer specified by Q_{\max} and Q_{\min} shall not be exceeded.

Three independent and identical tests shall be carried out at each flow rate. The result (absolute value) of each of these three tests must not exceed line B of Table 2 of OIML R 117-1.

The difference between the largest and the smallest results of the three successive measurements (range) is a measure of the repeatability error and shall, according to section 3.1.2.2 and A.6.1 of the International Recommendation R 117-1, not be greater than 2/5 of Line A in Table 2, for amounts greater than 5 times the minimum measured quantity.

If the measurement transducer is intended to be used together with a mechanical calculator/indicating device tests shall be performed at two unit prices which correspond to the maximum and minimum torques. This is generally near the maximum and minimum unit prices.

- 1 Fill in test report _____ (R 117-3).
- 2 Draw an error-curve with v_i as a function of Q for each liquid and each unit price (optional)

5.3.2.2 Accuracy at metering conditions for drum meters for alcohol

For drum meters for alcohol, this test is performed without the sampling device, if applicable.

Meters are tested at the following flow rates, 3 tests at each flowrate:

Table x

Drum meter	Flowrate (dm ³ /min)		
	Q_1	Q_2	Q_3
MPE (%)	0,2	0,25	0,3
small size (4 L per revolution)	0,5 to 1	1 to 2	2 to 3
big size (20 L per revolution)	3 to 5	5 to 10	10 to 15

MPE of reserve device (reserve drum) of big size drum meter is 0.6 % at all flowrates.

5.3.3 Accuracy at limits of temperature, pressure, viscosity and density

Perform tests according to 5.3.2 at limits of temperature, pressure, viscosity and density (when relevant, see OIML R 117-1 B.A.6.2), at 3 flow rates.

Note: See the Advice Annex Section X.5.3.3 for a table concerning advice on tests to be conducted on different meter technologies.

State in the pattern approval certificate if the meter can be verified in one liquid and used in another etc (OIML R 117-1 2.6.3).

5.3.4 Flow disturbances (OIML R 117-1 Sections 3.1.5.2, 3.1.6.1, 3.1.7.1, 3.1.8.1, 3.1.9.1)

This test is only to be completed with all manufacturer's installation requirements followed as described in Section 3.1.5.2 of R 117-1. If appropriate, meters may be tested with at least one flow disturbance, at minimum and maximum flow rate. Three independent and identical tests shall be carried out at both flow rates. The E_v of each test must not exceed line A in Table 2 of OIML R 117-1, without adjustment.

Alt 1. Use a "half-moon plate" in two orientations, 90° rotated, upstream the meter. The plate blocks 0,125 x D of the diameter (see OIML R49-2:2006 and ISO 4064-3:2005).

Alt 2. Use a ball valve upstream the meter or the measurement transducer in several valve opening positions (90°, 80°, 65°, 45°).

Other flow disturbance test procedures may also be used, but justification and documentation must be provided. If necessary, additional disturbance configurations may be defined by the technology of the meter. Note: See also Advice Annex X.5.3.4.

5.3.5. Drum meters for alcohol

5.3.5.1 Conversion device (OIML R 117-1 3.1.10.3)

The conversion device of a drum meter for alcohol is tested according to chapter 6, requirements according to OIML R22, reference temperature 20 °C.

5.3.5.2 Volume of individual measuring chambers (OIML R 117-1 3.1.10.1)

The volume of an individual measuring chamber must not deviate more than $\pm 0,2\%$ from the mean volume.

5.3.5.3 Inclined drum axis (OIML R 117-1 3.1.10.1)

Drum meters for alcohol are tested with drum axis inclined 3° to the horizontal, at minimum flow rate.

Three independent and identical tests shall be carried out at minimum flow rate.

The change in result must not exceed half of line B in Table 2 of OIML R 117-1.

5.3.5.4 Test of accuracy of the sampling device (3.1.10.4 of R 117-1)

Test of error of all sampling ladles is made during one revolution of the drum. MPE of n volumes of ladles (where n is number of chambers the drum) is 10 % of the sum of the volumes of all ladles of the drum.

5.3.5.5 Test of volume of the containers (3.1.10.4 of R 117-1)

The error of the volume compared to the nominal volume (stated in the type approval) shall not exceed;

- ±5 % for the collecting containers (for samples)
- 5 % for the volume of the inserting containers (for checking evaporation)
- 2,5 % for the surge container (for liquid if the drum gets stuck in the small size meter)

5.3.5.6 Test of accuracy of the thermometer (3.1.10.6 of R 117-1)

Accuracy of thermometer indication maximum temperature (to indicate a too high evaporation) shall not exceed ± 1 °C.

Note: Tests according 5.4.5.4, 5.4.5.5 and 5.4.5.6 are not intended for volume measurement, they are intended for revenue.

5.3.6 Other functional tests or requirements

5.3.6.3 Adjustment device (OIML R 117-1 3.1.3)

If the meter has a sealable adjustment device, the resolution shall permit an adjustment within:

- 0.05 % for meters intended for measuring systems with accuracy class 0.3;
- 0.1 % for meters intended for measuring systems with all other accuracy classes.

5.3.6.4 Correction device (OIML R 117-1 3.1.4)

The correction device is always considered as an integral part of the meter, and the requirements are applied to the corrected quantity.

The manufacturer must declare the correction device used. In combination with 5.4.2 and 5.4.3 the non-corrected and corrected quantity are compared to the correction applied. The correction shall only reduce the errors to as close to zero as possible (OIML R 117-1 3.1.4.3). See also checklist .

5.3.6.5 Checking facilities (OIML R 117-1 4.3.2)

See checklist in R 117-3 Section _____.

5.4 Endurance test

Object of the test

To determine the long-term stability of the meter sensor/measuring device. This test is only relevant for meters with moving parts.

Note: This is a SIGNIFICANT change from the endurance requirements of R 117-1. If approved, this change will be reflected in a future revision of R 117-1.

General information

An endurance test should be carried out at a flowrate between $0,8 \times Q_{\max}$ and Q_{\max} of the measurement transducer using the liquid the measurement transducer is intended to measure or a liquid with similar characteristics.

The measurement transducer shall be of the same type and model as used for the accuracy test, but need not be the same individual device. (Reference section 5.3.2)

When the transducer is intended to measure different liquids, the test should be carried out with the liquid that provides the most severe conditions (normally the liquid of lowest viscosity).

An accuracy test shall precede the endurance test.

In principle the duration of the endurance test shall be 100 hours in one or several periods. Details of these test procedures shall be fully documented in the test report (including the choice of test liquid).

After the endurance test, the measurement transducer is subject to an accuracy test. The deviation between the mean value of the errors after and before the endurance test shall remain within line B of Table 2 in OIML R 117-1 without any changes of the adjustment or corrections, as specified in section 3.1.2.3 of OIML R 117-1.

Test procedure

- 1 Perform accuracy tests in accordance with 5.4. at 3 flowrates (Q_{\min} , $0,25 \times Q_{\max}$, and Q_{\max}).
- 2 Calculate \bar{E}_{vi} (B) for each flowrate.
- 3 Operate the transducer for 100 hours at a flowrate between $0,8 \times Q_{\max}$ and Q_{\max} . For practical reasons, the volume may be divided in a number of deliveries.
- 4 Perform an accuracy test in accordance with 5.4 at the same three flowrates.. The unit price P_u shall be the same as during the initial accuracy test (only relevant for mechanical calculating/indicating devices).
- 5 Calculate \bar{E}_{vi} (A) and the difference \bar{E}_{vi} (A) - \bar{E}_{vi} (B) for each flowrate.
- 6 Fill in test report _____.

Note: If appropriate, the results from the accuracy tests according 5.4.2 can be used for step 1 of the test procedure. In this situation the middle flow rate is next lower flow rate from 5.4.2.

5.5 Accuracy on the minimum measured quantity

Object of the test

To determine the error of volume indication E_{vi} when the transducer delivers the minimum measured quantity.

Note: This testing requirement is not applicable for pipeline applications. For pipeline meters this test may be replaced by an evaluation/calculation of mmq considering cyclic volume, resolution, time constant and flowrate.

General information

The manufacturer or the applicant for OIML Certification of a measurement transducer has to define the minimum measured quantity. The indicating device used for test has to be suitable for this minimum measured quantity.

An accuracy test is made with a test volume equal to the minimum measured quantity at two flowrates, at Q_{min} and at the highest attainable flowrate, with standing start and stop (if applicable).

Three independent and identical tests shall be carried out at each flowrate.

The E_v must not exceed 2 times line B of Table 2 of OIML R 117-1.

Note : These tests shall be performed even if the requirements on uncertainty given in section 4.2 are not fulfilled because of the small volume related to scale interval.

If the measurement transducer is intended to be used with a mechanical calculator/indicating device, the tests shall be performed at the unit price which corresponds to the maximum torque. This is generally near the maximum unit price.

For electronic calculator/indicating devices the set unit price is not relevant.

- Fill in test report _____.

5.6 Additional testing procedures for electronic measuring devices (sensor + transducer)

5.6.1 General information

For electronic measuring devices, additional tests shall be performed. These tests aim at verifying that the electronic devices comply with the provisions of section 4.1.1 of OIML R 117-1 with regard to influence quantities.

- a) Performance tests under the effect of influence factors:
When subjected to the effect of influence factors the equipment shall continue to operate correctly and the errors shall not exceed the applicable maximum permissible errors.
- b) Performance tests under the effect of disturbances:

For interruptible systems, when subjected to external disturbances the equipment shall either continue to operate correctly or detect and indicate the presence of any significant faults. For non-interruptible systems, no significant fault shall occur.

Maximum Permissible Error (MPE)	Significant Fault (SF)
line B of Table 2 of OIML R 117-1	0.2 MPE

5.6.2 Test equipment

As described in section 5.2.

5.6.3 Test procedures

As described in the Section 4 with the following remarks:

Test only at one flow rate/simulated flow or at “zero flow”, with 3 tests for “Influence” and one test for “Disturbance”.

The internal processes in an electronic meter under no-flow conditions are almost identical to those taking place under flowing condition; therefore, these tests need not be performed under flowing conditions. Tests under reference conditions should then also be performed under no-flow conditions.

For electromagnetic and ultrasonic flowmeters it is usually necessary to fill the flowsensor with (conductive) liquid, to be able to get it in proper operating order.

Set the low-flow-cut-off, and damping to zero. (If the low-flow-cut-off can not be set to zero, one will not be able to observe small changes in flowrates around that value. One way to get around this problem is to create a systematic offset in flowrate, so that it indicates a flowrate larger than the low-flow-cut-off.)

Temperature measurement:

Electronic meters may be fitted with an internal temperature probe. When the temperature measurement is intended for internal corrections, the device is regarded to be an integral part of the meter, and is included in the testing.

Pressure measurement:

Pressure transmitters may be connected to an electronic meter for various purposes. If intended for correction, the pressure transmitter is considered as a part of the correction device and is included in the testing.

Test under reference conditions

Before the series of tests, the EUT’s performance under reference conditions is verified.

For all types of electronic meters, the flowrate indicated under reference conditions is the basis for all further performance tests.

For Coriolis meters (which need the volume output to be verified), the initial intrinsic error on the density indication must also be determined under reference conditions.

5.6.3.1 Test Method, Influence test type A

The object of an influence test is to verify that the electronic meter operates within its maximum permissible errors. Influence tests simulate the instrument's rated operating conditions.

Ambient temperature tests are only relevant when liquid temperature does not "create" the meter temperature completely.

During this type of Influence test, the meter's flow indication is used to determine if the meter still operates within the MPE's. However, maximum permissible errors apply to volume / mass and not flowrate. By calculating the effect of an observed change in flowrate on the device's minimum flowrate, the maximum influence on a volume / mass measurement is calculated, which must be smaller than the MPE. Expressed mathematically:

$$(\text{change in flowrate} / \text{minimum flowrate}) * 100\% < \text{MPE}$$

Please note that the effect decreases with increasing flowrate.

5.6.3.2 Test Method, Influence test type B

The only difference between an influence test of type A and B is that during a test of type B, the instrument is switched off when the influence factor is applied to the instrument. The instrument's performance is verified after the test. Typically these tests simulate conditions that the instrument is subjected to when it is not operating.

5.6.3.3 Test Method, Disturbance test

The object of a disturbance test is to verify that the instrument's behaviour does not change too much, due to the effects of disturbances. A disturbance test simulates conditions, which are not considered to be a rated operating condition.

During the presence of the disturbances, the device's flowrate indication must constantly be monitored for changes. The largest of these changes shall be no larger than the significant fault, when calculated as for Influence tests.

6 Testing Procedures for electronic calculators (that may be equipped with a conversion device), indicating devices, and associated devices.

6.1 General Information

Tests are performed under reference conditions.

The software and configuration shall be checked according the applicable requirements in Section 4 and the checklist in R 117-3.

Reference tests required in Section 6 are to be conducted before each test and after the final test of the day.

Results of testing conducted in accordance with Section 6 will be recorded in the applicable Sections of R 117-3.

6.1.1 Test setup

For electronic calculators and indication devices, the reference flow can be simulated (for instance by using a motor-driven pulser or electronic pulse simulator). In the case where the indicator is an integrated part of an electronic meter sensor, an electronic offset may be created to simulate a flow indication. It is advisable to apply at least 10000 pulses to minimize the uncertainty caused by pulse-counting. Sufficient pulses shall be applied to meet a uncertainty of 1/5 of the MPE to be verified.

One of the following approaches shall be used:

First approach:

(when associated measuring devices are included)

For the associate measuring instrument the reference method is applied like for example a temperature bath and/or pressure balance and/or reference liquid (to provide reference values for temperature, pressure, and density).

Second approach:

Simulated signals representing temperature, pressure and/or density are applied onto the EUT's inputs.

The true values for the simulated quantities are derived from the applied reference method, for example temperature is derived from the connected resistor (in case of simulated temperature dependent resistances); pressure can be derived from a generated current (in case of 4 – 20 mA pressure input).

6.1.2 Accuracy tests

Using an appropriate reference method, the values of the parameter characterizing the liquid are applied to the EUT.

6.1.3 Influence factor tests

For description of the tests see Section 4:

Dry heat:	see 4.8.5,
Cold:	see 4.8.6
Damp heat cycle:	see 4.8.7.
Vibration (random):	see 4.8.8
AC mains voltage variation:	see 4.9.2.1
DC mains voltage variation :	see 4.9.2.2:

During the climate tests, the equipment used for simulation of the deliveries and associated measuring instruments is kept outside the climatic chamber.

For each test the severity levels shall be determined. The levels for the tests are mentioned in the applicable articles; for the damp heat cycle test and vibration test article A.10.3 and A.10.4 are also applicable.

6.1.4 Electronic disturbance tests

For the severity levels see Section 4.9.1.1

For the description of the tests, see the following sections:

4.9.3 :	AC mains voltage dips, short interruptions and voltage variations
4.9.4 :	Bursts (transients) on AC and DC mains
4.9.5 :	Electrostatic discharge (ESD)
4.9.6 :	Fast transients/bursts on signal, data and control lines
4.9.7 :	Surges on signal, data and control lines
4.9.8 :	Voltage dips, short interruptions and voltage variations on DC mains power
4.9.9 :	Ripple on DC input power ports
4.9.10 :	Surges on AC and DC mains lines
4.9.11.1 :	Radiated, radio frequency, electromagnetic fields of general origin
4.9.11.2 :	Radiated, radio frequency, electromagnetic fields specifically caused by digital telephones
4.9.11.3 :	Conducted radio-frequency fields
4.10.2 :	Voltage variations (road vehicle battery)
4.10.3 :	Electrical transient conduction along supply lines (road vehicle battery)

In case of the radio frequency immunity tests, the equipment used for simulation of the deliveries and associated measuring instruments is kept outside the radio frequency chamber.

In the following paragraphs, the tables refer to the corresponding tables of R 117-3.

6.2 Electronic calculators and indicating devices

6.2.1 Accuracy tests (see future tables in R 117-3)

Using an appropriate reference method, three simulated flowrates (frequencies) are applied to the EUT: the minimum, medium and maximum value.

Based on the values applied by means of the reference methods and the volume (or mass, if that is the primary measurement signal) indicated by the calculator / indicating device the indicated value is compared with reference value.

Maximum permissible error: One tenth of the MPE defined in line A of table 2 (see R 117-1, article 2.8) Note: mpe requirement shall not be less than half of the scale interval.

Accuracy class	0.3	0.5	1.0	1.5
6.2.1 mpe	0.03 %	0.05 %	0.10 %	0.15 %

6.2.2 Influence factor tests (see future tables in R 117-3)

Dry heat test and cold tests

Before, during, and after the dry heat test and cold test, a delivery shall be simulated.

During the dry heat and cold test, the indicated quantity value is compared with the reference value.

Damp heat cycle test and vibration test

Before and after the damp heat cycle test and the vibration test, a simulated delivery is generated.

The indicated quantity value after the damp heat cycle test and vibration test is compared with the reference value.

During the damp heat cycle test and the vibration test, the power is switched off.

Maximum permissible error: One tenth of the MPE defined in line A of table 2 (see R 117-1, article 2.8) Note: mpe requirement shall not be less than half of the scale interval.

Accuracy class	0.3	0.5	1.0	1.5
6.2.2 mpe	0.03 %	0.05 %	0.10 %	0.15 %

6.2.3 Electrical disturbance tests

Before each test, reference deliveries are generated to determine the intrinsic error.

During the disturbance a simulated delivery is made, the indication of the indication device is compared with the reference values.

Maximum allowable variation

For interruptible systems:

Accuracy class	0.3	0.5	1.0	1.5
6.2.3 Significant fault	0.03 %	0.05 %	0.10 %	0.15 %

Checking facilities shall detect a malfunction and act upon it in accordance with R 117-1, article 4.3

For non-interruptible systems: no significant faults shall occur.

6.3 Conversion device (as part of an electronic calculator)

6.3.1 First approach

6.3.1.1 Accuracy tests

(see future tables in R 117-3)

If regarded as an Electronic Conversion Device, the applied associated measuring devices are considered to be an integral part of the conversion device. Consequently, a Conformity Assessment is only valid for the EUT, if applied in combination with the associated measuring device submitted with it for Conformity Assessment.

During tests, the specific test conditions need to be applied to the ECD including its associated measuring devices, using the reference method.

The indicated converted quantity value is compared with the reference converted value (using a internationally accepted method).

For the verification of the conversion calculation the measured volume or the volume derived from a simulated input is assumed to be without error.

Maximum permissible error, MPE = A-B of table 2 in R 117-1 (line C)

Accuracy class	0.3	0.5	1.0	1.5
6.3.1.1 mpe	0.10%	0.20 %	0.40 %	0.50 %

Note: mpe requirement shall not be less than half of the minimum specified quantity.

6.3.1.2 Influence factor tests

(see future tables in R 117-3)

If the transducers and the sensor of the associated measuring devices are separated, only the transducers together with the flowcomputer are placed in the climate room.

Dry heat test and cold tests

A delivery is simulated before, during, and after the dry heat test and cold test.

During the dry heat and cold test, the indicated converted quantity value is compared with the reference converted value (using an internationally accepted method).

Damp heat cycle test and vibration test

A delivery is simulated before and after the damp heat cycle test and the vibration test.

The indicated converted quantity value after the damp heat cycle test is compared with the reference converted value (using an international accepted method).

During the damp heat cycle test and the vibration test, the power is switched off

Maximum permissible errors, MPE = A-B of table 2 in R 117-1 (line C)

Accuracy class	0.3	0.5	1.0	1.5
6.3.1.2 mpe	0.10%	0.20 %	0.40 %	0.50 %

Note: mpe requirement shall not be less than half of the minimum specified quantity.

6.3.1.3 Electrical disturbance tests

(test results will be documented in the future tables of R 117-3)

Before and during the tests, a simulated delivery is generated.

During the tests, the indicated converted value is compared with the reference converted value (using an internationally accepted method).

Before and after each test, a reference non-converted value is generated to determine the intrinsic error.

All the different components are subject of the tests.

Maximum allowable variation

0.2 x MPE (see R 117-1, T.f.1 and Table 2 line A)

For interruptible systems:

Accuracy class	0.3	0.5	1.0	1.5
6.3.1.3 Significant fault	0.06 %	0.10 %	0.20 %	0.35 %

Or checking facilities detect a malfunctioning and act upon it accordance R 117-1, article 4.3

For non-interruptible systems: no significant errors shall occur.

6.3.2 Second Approach

6.3.2.1 Accuracy tests of the calculator/conversion device

(see future tables in R 117-3)

Following this second approach for the testing of a conversion device, it is possible to verify separately the accuracy of the associated measuring devices and to verify that the provisions for the calculator / indication device with conversion device are fulfilled.

The values represented by the simulated signals are to be compared with the values indicated by the flowcomputer.

For each of these quantities, the minimum, medium, and maximum values are applied. Based on the values represented by the simulated signals, the indications of the quantities are verified. (see R 117-1: table 4.1)

Based on internationally accepted standards and the values represented by the simulated signals, the correctness of the conversion calculation(s) are verified. (see R 117-1: article 2.7.2.1.3)

For the verification of the calculations, tests need to be performed at three points distributed over the range of the equation. For equations split into sections, three tests in each section need to be performed.

For the verification of the conversion calculation, the measured volume or the volume derived from a simulated input is assumed to be without error.

Maximum permissible errors (MPE), and significant faults, on measuring: (This table is for use with Sections 6.3.2.1, 6.3.2.2, and 6.3.2.3)		Accuracy class of the measuring system			
		0.3	0.5	1.0	1.5
Simulated signals	Conversion	0.03 %	0.05 %	0.10%	0.15%
	Temperature	± 0.18 °C	± 0.30 °C		
	Pressure	Less than 1 MPa		:	± 30 kPa
		Between 1 MPa and 4 MPa		:	± 3 %
		More than 4 MPa		:	± 120 kPa
Density (mass to volume conversion)	± 0.6 kg/m ³		± 1.2 kg/m ³		
Density (temp. or pressure conversion)	± 3 kg/m ³				

If the signals to simulate the associated measuring devices are digital, the MPE and significant fault of the indications are restricted to rounding errors. (see R 117-1, article 2.7.2.1.1)

6.3.2.2 Influence factor tests of the conversion/calculator device

(see future tables in R 117-3)

Dry heat test and cold tests

Before and after the dry heat test and cold tests, a simulated delivery is generated.

During the dry heat and cold test the indicated converted quantity value is compared with the reference converted value (using a international accepted method).

Damp heat cycle test and vibration test

Before and after the damp heat cycle test and vibration test, a simulated delivery is generated.

The indicated converted quantity value after the damp heat cycle test and vibration test is compared with the reference converted value (using an international accepted method).

During cycle test, and vibration test the power is switched off

Maximum permissible error – use the above table from Section 6.3.2.1.
(see also R 117-1 article 2.7.2.1, table 4.1)

If the signals to simulate the associated measuring devices are digital, the MPE and significant fault of the indications are restricted to rounding errors. (see R 117-1, article 2.7.2.1.1)

6.3.2.3 Electronic disturbance tests of the conversion/calculating device

(see future tables in R 117-3)

Before each test, a simulated reference delivery is generated to determine the intrinsic error.

The equipment used to simulate the signals shall not be influenced by the tests.

The quantities and the conversion calculation are verified using the values represented by the simulated signals and internationally accepted standards.

Maximum allowable variations – use the above table from Section 6.3.2.1.
(see also R 117-1 article 2.7.2.1, table 4.1)

If the signals to simulate the associated measuring devices are digital, the MPE and significant fault of the indications are restricted to rounded errors. (see R 117-1, article 2.7.2.1.1)

Checking facilities shall detect a malfunction and act upon it accordance R 117-1, Section 4.3.
For non-interruptible systems: no significant faults shall occur.

6.4 Associated Measuring Devices

6.4.1 Accuracy tests of associated measuring devices

(see future tables in R 117-3)

The associated measuring device is subjected to a known temperature, pressure or density. During tests, the specific test conditions need to be applied to the associated measuring devices using a reference method, (for example: a temperature bath and/or pressure balance and/or reference liquid (true values)). Traceable and documented laboratory reference equipment shall be used. The values indicated by the calculator/indicating device for each of the characteristic quantities shall be used to determine the error for each of the associated measuring devices.

Three values of the parameter characterizing the liquid are applied to the EUT: the minimum, median, and maximum value. The device is subjected to a known temperature, pressure, or density.

Based on the values applied by means of the reference method(s), the correctness of the values for temperature, pressure and/or density indicated on the Electronic Conversion Device or other indicating device is verified.

Maximum permissible errors (MPE), and significant faults, on measuring: (This table is for use with Sections 6.4.1, 6.4.2, and 6.4.3)		Accuracy class of the measuring system			
		0.3	0.5	1.0	1.5
Analog device					
	Temperature	± 0.24 °C	± 0.40 °C		
	Pressure	Less than 1 MPa : ± 40 kPa Between 1 MPa and 4 MPa : ± 4 % More than 4 MPa : ± 160 kPa			
	Density (mass to volume conversion)	± 0.8 kg/m ³		± 1.6 kg/m ³	
	Density (temp. or pressure conversion)	± 4 kg/m ³			
Digital device	Temperature	± 0.30 °C	± 0.50 °C		
	Pressure	Less than 1 MPa : ± 50 kPa Between 1 MPa and 4 MPa : ± 5 % More than 4 MPa : ± 200 kPa			
	Density (mass to volume conversion)	± 1.0 kg/m ³		± 2.0 kg/m ³	
	Density (temp. or pressure conversion)	± 5 kg/m ³			

6.4.2 Influence factor tests on associated measuring devices (see future tables in R 117-3)

Dry heat test and cold tests

Before, during, and after the dry heat test and cold tests, the indicated measured value is compared with the reference value.

Damp heat cycle test and vibration test

Before and after the damp heat cycle test and vibration tests, the indicated measured value is compared with the reference value.

During damp heat cycle test and the vibration test, the power is switched off

Maximum permissible error – use table from Section 6.4.1.
(see also R 117-1, Section 4.2 and 4.3)

6.4.3 Electrical disturbance tests on associated measuring devices (see future tables in R 117-3)

Before each test the indicated value is compared with the reference value to determine the intrinsic error

The reference equipment shall not be influenced by the tests

The correctness of the quantities indications are verified by comparing them with the reference values.

Maximum allowable variations– use table from Section 6.4.1.
(see also R 117-1, Section 4.2 and 4.3)

6.5 Temperature conversion: Tests on response time of the measuring system temperature sensor. (see future tables in R 117-3)

See R 117-1, Sections 3.7.7 and 6.1.10 for further discussions on these requirements.

The desired temperature change is applied to the EUT using a suitable reference method. The output from the sensor has to be able to respond to 90% of a temperature step-change within 15 seconds or (if larger) within a time corresponding to the time needed to deliver, at Q_{\max} , a quantity of twice the MMQ.

In the case of fuel dispensers, this would result in maximum time constants (τ) as found in the following table:

Table for Section 6.5				
Q_{\max} [L/min]	40	80	130	200
MMQ [L]	5	10	20	50
Time [s]	15.00	15.00	18.46	30.00
Maximum Tau [s]	6.51	6.51	8.02	13.03

See also IEC 60751.

7 Testing procedures for gas elimination devices

7.1 General Information

Section 7 covers testing procedures for all three types of gas elimination devices: gas separators, gas extractors, and special gas extractors.

7.2 Description of the test stand (general)

Tests on gas elimination devices should be carried out for flow rates up to a maximum of 100 m³/h. For higher flow rates, characteristics may be determined by analogy with equipment of the same design and smaller dimensions. “By analogy” means that parameters like Reynolds number, Froude number, etc. are to be taken into account for the gas elimination device.

The liquid used for the tests should either be the same as that for which the device is intended or should be of a viscosity which is at least equal to that of the liquid for which it is intended. If the gas separator fulfills the 0.5 % error requirement with a liquid that has a viscosity greater than 1 mPa·s (at 20 °C), no additional tests with a test liquid with a viscosity less than 1 mPa·s are required.

The capacity of the proving tank should be at least equal to the volume delivered in one minute at maximum flow rate of the EUT.

The gas/air is injected into the test liquid of the EUT downstream of the pump. The air inlet is fitted with a shut-off/control valve and a check valve to prevent liquid from entering the inlet and draining out of the measurement system. A pressure gauge is located at the air inlet – this allows the calculation of the air volume at atmospheric pressure.

A sight glass has to be installed behind or downstream of the air inlet. The added air has to be noticed in the test liquid. (Hint: if the liquid pressure is too high the gas could be entrained into the liquid, this would make the function of removing gas from the liquid impossible to test). To visually check the absorbance of gas, the vent pipe of the gas extractor has to end in a bucket filled with liquid. Air bubbles have to be seen for demonstration of the removal of air from the liquid.

The volume of gas/air continuously entering the liquid may be measured by a gas meter and isothermally converted to atmospheric pressure on the basis of the indication of a pressure gauge fitted upstream of the gas meter.

The liquid pressure is required to be measured directly downstream of the gas separator. A sight glass should be used to check that the gas/air is no longer visible in the liquid.

Positive displacement (PD) meters are preferred for this testing because of their ability to measure actual volume. Before the tests, the liquid meters upstream and downstream of the EUT need to be calibrated at the same time to define their inherent error.

7.3 Test Preparation

The tests are required to be conducted at the maximum flow rate and minimum pressure (< 2 bar). During the entire test period of at least 1 minute, the gas/air mixture is continuously added. The gas-liquid ratio is limited to 30% gas (under ambient conditions) for gas separators with a flowrate of greater than 20 m³/h. The gas elimination device must separate all of the injected gas/air and must be fully functional.

The maximum additional error for test liquids with a viscosity greater than 1 mPa·s (at 20 °C) shall not be higher than 1% (< 1 mPa·s, not higher than 0.5 %) of the metered volume or 1% of MMQ.

Before any tests are conducted, the test set up must be vented of any entrapped air.

7.4 Execution of the test

Make at least six measurements with the control valve open in increasing amounts of gas/air into the liquid.

Test steps

1. Set the entry of air to 0%.
2. Wet and drain the complete system.
3. Do the tests at the maximum attainable flow rate at the lowest liquid pressure.
4. Note the air bubbles in the sight glass upstream the DUT
5. Check the liquid and gas flow rate together with the pressure values
6. Stop the flow of air and liquid
7. Read the reference volume V_p of Z1 and the measured volume V_m of Z2
8. Calculate, with the help of the value of compressed air, the amount of air V_{air} at atmospheric pressure.
9. Calculate the ratio of V_{air}/V_p and the error $(V_m - V_p)/V_p$.
10. Repeat step 3 to 9 in several steps up to 30 %.
11. Draw the error curve as a function of supplied air.

The amount of added air has to be calculated according this formula.

$$V_{ambient} = \frac{V_{metered-air} \cdot (P_{metered-air} + P_{ambient})}{P_{ambient}}$$

See Advice Annex Section X.7.4, Figure 1 for a diagram of a suggested gas separator test stand.

7.4.1 Tests on gas extractors (and gas separators)

An example of test set-up which will add air pockets (slug air) to a liquid stream is shown in Advice Annex X.7.4, Figures 2 and 3.

The test set-up in figure 1 includes a vessel which serves as a gas reservoir for creating the air pocket. This air pocket is then added to the liquid stream at the highest nominal flow rate of the

gas extractor. The volume of the gas pocket is equal to the minimum measured quantity of the gas extractor (the minimum measured quantity of the system is normally not known and it has to be substituted by a typical value depending on the size of gas separator).

As a general rule the MMQ can be set to the volume of 1 minute flow at Q_{min} . If only the Q_{max} is known, then Q_{min} can be set to 1/10 of Q_{max} and the Volume for the gas reservoir at atmospheric pressure is defined

The tests have to be made at maximum flow rate and the lowest possible hydraulic pressure. The lowest possible hydraulic pressure has to be smaller than 2 bar because the gas could be entrained into the liquid, this would make the function of removing gas from the liquid difficult to test.

Prior to establishing the measurement error due to the air pockets or slug air, tests shall be conducted to verify the accuracy of the single test meter. Once the meter error curve is verified then the testing of the EUT can commence. The volumetric prover / gravimetric tank should be sized to allow one minute of flow at the EUT's maximum flow rate.

The preferred type of the test meter Z1 is a PD or piston meter because of the direct volume measurement.

The test set-up shown in Advice Annex X.7.4 Figure 2 can be used for testing the EUT for its effectiveness for removing slug air.

In this set-up, one tank is filled with a volume that will be exhausted sometime during the test prior to filling the volumetric prover or gravimetric tank. After the first product tank is drained, and the indicating device should not register for at least ten seconds, then the tank control valves will be switched allowing product from the second tank to be pumped to complete the test. The allowable error must be within the MPE value.

7.4.1.1. Test Requirements

Gas elimination devices have to be inside the MPE defined in OIML R 117-1 2.10 for the extraction of air and gas pockets under the following test conditions:

The duration of test has to be at least for 1 minute at maximum flow. The maximum additional error for test liquids with a viscosity $> 1 \text{ mPa}\cdot\text{s}$ shall not higher than 1% ($< 1 \text{ mPa}\cdot\text{s}$ not higher than 0.5 %) of the metered volume or 1% of MMQ.

7.4.1.2 Preparing the test bench

The liquid used for the tests should either be the same as that for which the device is intended or should be of a viscosity which is at least equal to that of the liquid for which it is intended. If the gas separator fulfills the 0.5 % requirement with a liquid $> 1 \text{ mPa}\cdot\text{s}$ no additional tests with a test liquid $< 1 \text{ mPa}\cdot\text{s}$ are required.

Before any tests are conducted the test set up; including the gas reservoir must be vented of any entrapped air.

Three initial tests must to be made without any air or gas pockets (see Figures in Advice Annex X.7.4)

- Figure 2: stop valve V1 is closed, stop valve V2 is open

- Figure 3: tanks must contain enough liquid to run the test complete without being allowed to draw in air

The measurement of the meter, prover reading / (gravimetric readings), and temperature must be recorded and shall follow the recommend practices of volumetric / gravimetric proving methods.

Note: Gravimetric proving also requires density information of the liquid.

7.4.1.3 Test with air pockets (Advice Annex X.7.4, Figure 2, preferred for refinery applications)

Prepare the gas reservoir; switch off the pump so that the test bench does not have any pressure applied. Open the air inlet valve and the drain valve of the gas reservoir. Measure the drained liquid. The volume of the drained liquid is equal to the volume of the intended gas pocket under atmospheric pressure used for the test. Both valves have to be closed once the necessary amount of air (gas volume equal to MMQ) is reached in the measuring container being filled from the drain line.

Switch on the pump and set the test bench to maximum flow rate of the EUT. Open stop valve V1 completely and shut stop valve V2. Liquid is now flowing in the gas reservoir vessel and will push the gas into the system. The air pocket must be observed in the sight glass upstream of the EUT. If the EUT detects the air it will be vented via the gas vent line to a bucket filled with liquid. Bubbles must be observed during this process. Resume the test for a minimum of at least one minute before concluding the test.

Compare the meter indicated volume with the volume of the prover can or calculated from the weight indication of the scale. The deviation between these volumes, by taking into account the inherent errors, has to be smaller than 1% of MMQ. Repeat this test 3 times. Errors can not exceed 1% of MMQ.

7.4.1.4 Test with slug air (Advice Annex X.7.4, preferential for gas extractors for tank trucks only with a pump)

Fill one tank with just enough liquid so it will be depleted during the test (i.e. about half of the tank capacity of the prover). Open the valve on the first tank with the low liquid level, start the pump and ensure it is pumping at the EUT's Q_{max} rate. Upon depleting the liquid in the first tank let the pump run for at least ten seconds which is than equal to a amount of a MMQ air pocket, the indicating device should not register during this time, if the indications jump during the ten second waiting period then wait one minute before switching tank valves . Close the first tank valve and then open the second tank valve. The air pocket must be observed in the sight glass upstream of the EUT. If the EUT detects the air it will be vented via the gas vent line to a bucket filled with liquid. Bubbles must be observed during this process. The indicating device should resume a normal count sequence once the EUT vents the air. The test is concluded once the volumetric prover is filled. Record the indicated value from the meters indicating device and compare the value with the actual value as measured by the volumetric prover.

The deviation between the meter (Z1) and the volumetric volume values (or gravimetric values), by taking into account the inherent errors, has to be smaller than 1% of MMQ. Repeat this test 3 times. Errors shall not exceed 1% of MMQ.

7.5 Special Gas Extractor Testing

See Advice Annex X.7.4, Figure 3, for the suggested layout diagram of the special gas extractor test bench.

7.5.1 Test sample

The test sample (EUT) is a special gas extractor designed for installations in measuring systems on tank trucks for low-viscosity fuels ($< 20\text{mPa}\cdot\text{s}$).

The measurement is automatically interrupted if gases should penetrate or are already present in the special gas extractor. The ventilation, required after switching off the special gas extractor and the subsequent continuation of the measuring process also takes place automatically.

7.5.2 Test stand for gravity discharge

To perform gravity discharge tests there must be a static height difference (h_1) between the storage tank and the meter and between (h_2) the meter and the test container (B3). The height difference (h_1) shall be at least above the minimum liquid level for correct working of the special gas extractor and meter. Opening the valves of the storage tank shall flood the gas separator. Before testing, the meter and the pipe work up to valve (V21) has to be filled with test liquid. To get a high flow rate the height (h_2) should be as large as possible.

The use of a suction pump at the outlet of (V23) should not be used, because determining the start and end condition of remaining product in the pump is not well defined.

7.5.3 Meter for dynamic measurement

A positive displacement meter is used as the volumetric meter and is checked against the scale. The meter measures the test liquid together with the remaining gas, which is not released by the special gas extractor, and is an indicator of the efficiency of the special gas extractor.

7.5.4 Tests

The following tests are required according OIML R 117-1 and will be performed

- the behaviour of the special gas extractor in normal operating mode
- the residual discharge from storage tanks (B1) and (B2)
- the empty compartment test
- the behaviour of the special gas extractor with continuous air supply
- test of gas pockets

All tests are carried out according the specification of the special gas extractor with gravity and pumped discharge and have to be repeated at least three times.

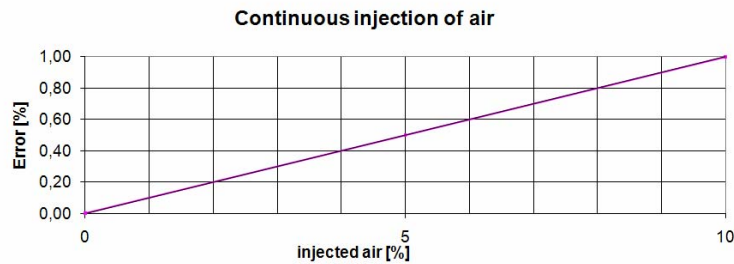
All measurements are started via an additional flow computer (not shown in the test bench layout).

The flow computer displays the temperature (T_1), the volumetric flow rate (Q) and the total volume delivered (VT).

If the special gas extractor can meet the requirements of the continuous air supply test for liquids $< 1\text{ mPa}\cdot\text{s}$ (0.5%) then testing with one liquid $> 1\text{ mPa}\cdot\text{s}$ is sufficient.

For the continuous air supply test the error of the special gas extractor has to be 0 at 0% added air and increase by a straight line, starting at zero and going through the point at max. error (0.5

% or 1%) at 5% added air. The additional error from the injected air has to be equal/below this straight line.



For all other tests the additional error has to be smaller than the allowed error of 1%.

The error curve of the meter has to be determined in order to calculate the corrected test volumes.

7.5.5 Performing the tests

7.5.5.1 Filling the storage tanks (B1 and/or B2)

The storage tanks (B1) and (B2) are filled with the test liquid by valves (V3 and V4).

Control of the filling valves (V3 and V4) is coupled with the overfill preventing level sensors in the storage tanks (B1) and (B2). When a critical filling level is reached the valves automatically close and prevents overflow.

The valves (V3) and (V4) are the respective filling valves of the storage tanks.

7.5.5.2 Emptying the test container (B3)

After completion of the measurement, the test container (B3) is emptied via an inlet manifold and the pump (K2). After closing valve (V27), open valve (V26, V24, V3, and/or V4), The test liquid will return to the storage tank (B1) or (B2).

7.5.5.3 Pipe connection for gravity discharge

During all tests valves (V27) and (V6) are open and valves (V26, V24, V3, and V4) are closed.

7.5.5.4 Pipe connection for pumped and gravity discharge tests

During gravity discharge tests, the test liquid flows via the foot valves (V1 and/or V2), (V5) and (V6) to the test sample (DuT).

For pumped discharge tests valve (V5) has to be closed and the pump K1 has to be switched on.

7.5.5.5 Tests with continuous air supply

When testing the air separation behaviour, a continuous supply of air will be added to the test liquid. In order to supply air to the test liquid valve (V17) has to be opened. The air flow will be set up with a throttle valve (V34), air flow meter (Z2), and flow indicator (23).

Valve (V16) will be automatically opened when valve (V21) is released by the special gas extractor and test liquid is flowing.

7.5.5.6 Throttling upstream of the test sample (pumped discharge)

The flow is throttled via the electronic speed control of pump (K1). The volume flow rate is indicated at the flow computer display.

7.5.5.7 Throttling downstream of the test sample (gravity discharge)

The flow rate is throttled via the valve (V23) to make sure that meter (Z1) is constantly flooded. The volume flow rate is indicated at the flow computer display.

7.5.6 Test execution

All tests are carried out at the maximum rated flow rate of the special gas extractor.

The maximum achievable flow rate at gravity discharge is normally below the maximum rated flow rate of the special gas extractor. To reach the rated flow rate of the special gas extractor (DuT) the gravity discharge must be supported by simulating an increased static height. This will be done by putting pressurized air on compartment B2. An increase of around 0.4 bar which could vary of the used tank size results in a simulated increase of the static height by 4 m. This has to be done to fulfil the OIML R 117-1 for testing at maximum flow rate. A pressure regulator guarantees stable air pressure in the compartment during the tests.

Before each measurement the test container has to be emptied, the scales (W1) has to be reset to zero and the flow computer needs to be reset in order to begin the next test..

7.6 Description of the tests

7.6.1 Testing of the air separation behaviour for residual discharge

Testing of the air separation behaviour for residual discharge is carried out respectively with the amount of the maximum flow rate for 1 minute of test liquid from storage tanks (B1) or (B2). The pipe route is enabled depending on the type of test (gravity discharge or pump operation). The butterfly valve (V23) downstream of the test sample is fully open. After pressing the start button on the flow computer the stop valve (V21) opens and the test liquid flows through the test sample (DuT) into the test container (B3).

If the storage tank (B1) is completely empty and the special gas extractor (DuT) doesn't operate valve (V21), the measuring process is finished. After measurement the discharge pipe is ventilated. All measuring results will be recorded in a measurement protocol.

7.6.2 Testing of the air separation behaviour for empty compartment test

When testing the air separation behaviour by means of connecting an empty compartment, the test sequence is as follows: One of the two storage tanks is filled with test liquid. The valves in the pipes are switched depending on the type of test (gravity discharge or pump operation). After pressing the start button on the flow computer the stop valve (V21) opens and the test liquid flows through the test sample (DuT) into the test container (B3) at the maximum flow rate.

If the maximum flow rate has been achieved, the foot valve of the empty storage tank (V1 or V2) is opened and the foot valve of the storage tank in use is closed (V1 or V2). When the special gas

extractor interrupts the flow the empty compartment is closed and the full compartment is opened again.

After 1 minute of flow at the maximum flow rate the valve (V21) is closed and the measurement is finished. After completion of the measurement the discharge pipe downstream of (V21) has to be ventilated. All measuring results are recorded in a measurement protocol.

An additional test is to empty one compartment completely and resume the test from another full compartment.

7.6.3 Testing of the air separation behaviour with continuous air supply

Testing is carried out as follows: To test the behaviour with continuous air injection, the storage tank (B2) is filled with test liquid. The valves in the pipes are switched depending on the type of test (gravity discharge or pump operation). If the shut off speed of the stop valve (V21) is important for the performance of the special gas separator the type of the stop valve has to be recorded in the report. After pressing the start button on the flow computer the stop valve (V21) is opened. The test liquid flows through the test sample (DuT) into the test container (B3).

While the test liquid is at maximum flow rate through the special gas extractor, a control unit ensures that a continuous flow of compressed air is simultaneously blown into the pipe system. If the liquid measuring process is interrupted by the special gas extractor, then the stop valve (V21) and the valve (V16) are closed and the flow of the test liquid and compressed air supply is interrupted.

Using the gas meter (Z2) and the pressure of the gas (P2), the percentage of gas volume related to the test liquid volume can be calculated.

After 1 minute of flow at the maximum flow rate the butterfly valve (V23) is closed and the measurement is finished. After completion of the measurement the discharge pipe downstream of (V21) has to be ventilated. All measuring results are recorded in a measurement protocol.

7.6.4 Testing of gas pockets (only pumped discharge)

To do the gas pocket test there is a need for a long pipe work or a gas container to store the adequate volume of gas (OIML R 117-1 volume should be of the volume of Minimum Measure Quantity (MMQ)). The gas should be queued to enter the test system once at maximum flow rate. If this test is not feasible an adequate replacement test has to be made. The test is similar to the test for residual discharge until the compartment becomes empty. If air breaks into the pipe work the associated stop valve (V6) has to immediately be closed. At the same moment air of the volume of MMQ under atmospheric conditions is injected via (V15) to simulate the gas pocket (according OIML R 117-1). After injecting the required amount of air the air flow is stopped and (V6) is opened again. The test will be resumed at the maximum flow rate.

After 1 minute of flow at the maximum flow rate the butterfly valve (V23) is closed and the measurement is finished. After completion of the measurement the discharge pipe downstream of (V21) has to be ventilated. All measuring results are recorded in a measurement protocol.

7.7 Density (ρ) of the test liquid

For the later calculation the density of the test liquid is needed. To use the correct values the density of the test liquid will be checked at different temperatures by means of calibrated meter. A table will be set up for these conversion calculations.

7.8 Scales

A calibrated Self-indicating electromechanical scale is used as the working standard for testing. Instead of a scale it is also possible to use proving cans but for practical reasons (height and fixed volume of proving cans) a scale is the first choice for the tests.

7.9 Pneumatic pipe work

The pneumatic pipe work for the test setup is the standard pneumatic pipe work used in service with additional pneumatic pipe work to run the tests. This additional pneumatic pipe work shall be decoupled by the fast venting valve to have no influence to the standard pipe work and the time behaviour of the stop valve (V21).

7.10 Formulas for the calculation of the test results

Error correction of volume: $V_k [L] = V_T * (1 - \text{error of measuring system} / 100)$ (1)

Error correction due to buoyancy of the test medium
when measuring with one pair of scales: $W_{kg} [kg] = W * (1 - 1,2 / 8000) / (1 - 1,2 / \rho)$ (2)
Density $\rho [kg/m^3]$

Conversion of the weight of the test medium
into a volume: $W_l [L] = W_{kg} / \rho * 1000$ (3)
Density $\rho [kg/m^3]$

Calculation of the error in litres: $F [L] = V_k - W_l$ (4)

Calculation of the real error by means
of an additional air supply: $F_{rel.} [\%] = (V_k - W_l) / W_l * 100$ (5)

Error correction of the gas volume: $A_{corr} [L] = (A_1 - A_2) * (1 - \text{error of the gas meter} / 100)$ (6)
A1 gas meter value at start,
A2 gas meter value at end of the test

Calculation of the volume of the
continuously added compressed air:

$$F_{\text{add}} [\text{L}] = A_{\text{corr}} * (P_2 + 1) / (P_3 + 1) \quad (7)$$

Calculation of the percentile volume of the
continuously added compressed air:

$$F_z [\%] = F_{\text{add}} / W_1 * 100 \quad (8)$$

Calculation of the air volume at atmospheric conditions

$$V_{\text{atm}} [\text{L}] = A_{\text{corr}} (1 + P_2) / 1 [\text{bar}] \quad (9)$$

Rem.: $P_3 = 0$ bar in (7)

8 Test Procedures for Ancillary Devices

8.1 General Information

The test procedures detailed in Section 8 apply to the following ancillary devices:

- Printing devices;
- Memory/Storage devices – Data Storage Devices (DSDs); and
- Conversion devices.

Note: depending on national legislation, printing devices have their specific requirements on a checklist (in R 117-3) and not be able to obtain a separate OIML type approval.

Electronic ancillary devices shall be tested for immunity to the following electrical disturbance tests.

The testing laboratory shall ensure that environmental tests for ancillary devices are correct for intended use of the device (as specified by the manufacturer).

For electronic ancillary devices powered by batteries, there is a distinction between the tests for instruments powered by:

- (a) Disposable batteries;
- (b) General rechargeable batteries; and
- (c) Batteries of road vehicles.

In the case of disposable and rechargeable batteries of a general nature, there are no applicable standards available.

Devices powered by non-rechargeable batteries or by rechargeable batteries that cannot be (re)charged during the operation of the measuring system, shall comply with the following requirements:

- (a) The device provided with new or fully charged batteries of the specified type shall comply with the applicable metrological requirements;
- (b) As soon as the battery voltage has dropped to a value specified by the manufacturer as the minimum value of voltage where the device complies with metrological requirements, this shall be detected and acted upon by the device in accordance with Section 4.2 of R 117-1.

For these devices, no special tests for disturbances associated with the "mains" power are required.

Devices powered by rechargeable auxiliary batteries that are intended be (re)charged during the operation of the measuring instrument shall both:

- (a) comply with the requirements for devices powered by non-rechargeable batteries or by rechargeable batteries that cannot be (re)charged during the operation of the measuring system, with the mains power switched off; and
- (b) comply with the requirements for AC mains powered devices with the mains power switched on.

Devices powered by mains power and provided with a back-up battery for data-storage only, shall comply with the requirements for AC mains powered devices.

For electronic devices powered by the on-board battery of a road vehicle, a series of special tests for disturbances associated with the power supply are given in Section 4.10.

Notes:

- Ancillary devices that are powered directly, and not provided with power from/by the measuring device, may be tested as “stand-alone” units.
- Ancillary devices that are provided with power from/by the measuring device shall be tested installed in a measuring system, or equivalent simulator.

8.2 Electronic disturbance tests on electronic ancillary devices

For the severity levels see Section 4.9.1.1

For the description of the tests, see the following sections:

- 4.9.2.1 AC mains voltage variation
- 4.9.2.2: DC mains voltage variation
- 4.9.3 : AC mains voltage dips, short interruptions and voltage variations
- 4.9.4 : Bursts (transients) on AC and DC mains
- 4.9.5 : Electrostatic discharge (ESD)
- 4.9.6 : Fast transients/bursts on signal, data and control lines
- 4.9.7 : Surges on signal, data and control lines
- 4.9.8 : Voltage dips, short interruptions and voltage variations on DC mains power
- 4.9.9 : Ripple on DC input power ports
- 4.9.10 : Surges on AC and DC mains lines
- 4.9.11.1 : Radiated, radio frequency, electromagnetic fields of general origin
- 4.9.11.2 : Radiated, radio frequency, electromagnetic fields specifically caused by digital telephones
- 4.9.11.3 : Conducted radio-frequency fields
- 4.10.2 : Voltage variations (road vehicle battery)
- 4.10.3 : Electrical transient conduction along supply lines (road vehicle battery)

8.3 Printing devices

The EUT may consist solely of a printing device or of a measuring system connected to a printing device. The test consists of exposure of the EUT to the specified power condition while the printing device is operating under normal atmospheric conditions. During tests, the EUT shall be in operation, simulated inputs (where applicable) are permitted.

When the printing device is tested separately from the measuring system, or the simulator, shall not be subject to the test conditions. However this may not be possible if the printing device is an integral device.

The use of a recording device (printer or storage) makes sense only if the measurement result used for the transaction is printed, or recorded, together with some form of identification (e.g. time & date). The identification gives the possibility to the client of the transaction, or to a third party involved in the result, to check the correctness of measurement data in case of doubt.

8.3.1 Electronic disturbance tests for printing devices

The classification of the instrument for electrical disturbance tests is given in the first table of Section 4.9.

The relation between the class and the applicable severity levels is given in the second table of Section 4.9.

The measuring system, or simulator, is operated to establish the primary indications, i.e. a quantity indication and, if applicable, a unit price and price to pay. The EUT shall be in operation during test(s), and a print is to be initiated.

The printout of the primary indications provided by the printing device shall not deviate from (each of) the primary indications on the measuring instrument, or simulator, by more than one scale interval or the greater of the two scale intervals if they differ (R 117-1, 5.10.1.3).

Any value shall be printed as a repeated value from the measuring system or simulator (R 117-1, 3.4.7).

8.3.2 Tests for Printing Devices Powered by a road vehicle battery

The tests for devices powered from a road vehicle battery are described in Section 4.10.

8.4 Memory / Storage Devices (Data Storage Device- DSD)

The EUT may consist solely of a DSD, or of a DSD connected to a measuring system. The test consists of exposure of the EUT to the specified power condition while the DSD is operating under normal atmospheric conditions. During tests, the EUT shall be in operation, simulated inputs (where applicable) are permitted.

When the DSD is tested separately the measuring system, or the simulator, shall not be subject to the test conditions, however this may not be possible if the DSD is an integral device.

The use of a recording device (printer or storage) makes sense only if the measurement result used for the transaction is printed or recorded together with some form of identification. The identification gives the possibility to the client of the transaction, or to a third party involved in

the result, to check the correctness of measurement data in case of doubt. Therefore the data stored must be capable of being identified and displayed. In case of a printout the identification shall be printed

If the recording device ceases to operate, then the measuring system should either cease to operate or alert the operator.

The data stored must contain all relevant information necessary to reconstruct an earlier measurement, and be protected against unintentional and intentional changes with common software tools.

These procedures will only check that the data are stored correctly and given back correctly.

The relevant data which are used for a transaction must be stored automatically.

Note: This requirement means that the storing function must not depend on the decision of the person operating the system.

8.4.1 Electronic disturbance tests for memory/storage devices

The classification of the instrument for electrical disturbance tests is given in the first table of Section 4.9.

The relation between the class and the applicable severity levels is given in the second table of Section 4.9.

The measuring system, or simulator, is operated to establish the primary indications, i.e. a quantity indication and, if applicable, a unit price and price to pay. The EUT shall be in operation during test(s).

It shall be possible to verify that the stored data corresponds to the data provided by the calculator and that restored data accurately corresponds to stored data.

8.4.2 Tests for memory/storage devices powered by a road vehicle battery

The tests for devices powered from a road vehicle battery are described in Section 4.10.

8.5 Conversion devices

Section 8.5 covers “stand-alone” conversion devices. Test procedures for conversion devices that are part of an electronic calculator are found in Section 6.3

The EUT may consist solely of a conversion device or of a conversion device connected to a measuring system. The test consists of exposure of the EUT to the specified power condition while the conversion device is operating under normal atmospheric conditions. During tests, the EUT shall be in operation, simulated inputs (where applicable) are permitted.

When the conversion device is tested separately the measuring system, or the simulator, shall not be subject to the test conditions. However this may not be possible if the conversion device is an integral device.

The classification of the instrument for electrical disturbance tests is given in the first table of OIML R 117-1 section A.11.1.1

8.5.1 Electronic disturbance tests for conversion devices

The classification of the instrument for electrical disturbance tests is given in the first table of Section 4.9.

The relation between the class and the applicable severity levels is given in the second table of Section 4.9.

The measuring system, or simulator, is operated to establish the primary indications, i.e. a quantity indication and, if applicable, a unit price and price to pay. The EUT shall be in operation during test(s).

8.5.2 Tests for conversion devices powered by a road vehicle battery

The tests for devices powered from a road vehicle battery are described in Section 4.10.

Annex A

Testing procedures for fuel dispensers

A.1 General Information

Test procedures in Annex A are applicable for fuel dispensers and blend dispensers. General requirements for the type approval of a complete measuring system are given in Section 6.1.10 of R 117-1.

(Note: A separate Annex will include test procedures for LPG dispensers – but this Annex will be added in a future draft of R 117-2.)

The Q_{\max}/Q_{\min} ratio must be 10 or larger. A ratio of less than 10 is not relevant for type approval procedures for fuel dispensers.

The type approval of a fuel dispenser consists of:

- (1) approving the entire system, and
- (2) verifying that the constituent elements (which have not received separate test reports/type approvals), are compatible and satisfy the applicable requirements.

Appropriate testing procedures for the type approval of a fuel dispenser shall be determined after a full review and consideration of the test reports/type approvals already granted for the constituent elements of the measuring system.

When the constituent elements have not been tested or received separate type approval, all the tests provided in Sections 4, 5, 6, 7, and 8 shall be performed.

When the various constituent elements have all been tested/approved separately, it may be possible to forego type approval testing with a full review of previously-issued type approval documentation/drawings of the constituent elements. In this case, it may be appropriate to perform accuracy tests on the complete measuring system due to the possible influence of hose or hydraulic conditions.

Before conducting type approval tests, it is necessary to execute a design evaluation of the fuel dispenser by using the general check-list provided in R 117-3.

A.2 Testing procedures for meters

Testing is completed in accordance with Section 5. These tests include:

- Accuracy tests;
- Tests on the minimum measured quantity (with maximum specified hose length);
- Endurance testing; and
- Non-return valve configuration and reverse count detection.

A.3 Testing procedures for electronic devices: calculator, correction, indicating, and associated devices

Testing is completed in accordance with Section 6.

A.4 Testing procedures for gas elimination devices

Testing is completed in accordance with Section 7.

Note : if the measuring system is not fitted with a gas elimination device, the requirements of Sections 2.10 and 5.1.3 of R 117-1 shall be fulfilled.

A.5 Testing procedures for ancillary devices

Testing is completed in accordance with Section 8.

A.6 Additional testing procedures for complete fuel dispensers

A.6.1 Testing procedure related to flow interruption – with maximum specified hose length (this test is only applicable for fuel dispensers with mechanical calculators)

Objective of the test

To determine the effect of sudden pressure variations on the accuracy (applicable MPE is R 117-1, Table 2, Line A).

Test procedure

The interruption test shall be performed three times at the maximum flowrate of the fuel dispenser. The test volume shall be not more than the volume delivered in one minute at Q_{\max} . Using the nozzle, the liquid flow is started and stopped abruptly five times during the same measurement. These stops shall be made at various time intervals.

A.6.2 Testing procedures related to fuel dispenser hoses

Hoses do not receive separate type approval; however, all systems shall fulfil the hose-related requirements of R 117-1 – 5.1.14. The hose dilation and vaporization quantity need to be less than the allowed hidden quantity. Testing advice on a procedure for a test on hose dilation can be found in the advice Annex X.A.6.2 (see also 2.15, 6.2.2.1, and B.6.1.10 in R 117-1)

A.6.3 Other fuel dispenser functionality to be tested:

- Functional test of communication protocols,
- Temperature compensation, (Temperature measurement, position of probe)
- Electronic calibration.

Annex B

Testing procedures for measuring systems on road tankers

The tests in Annex B apply to measuring systems mounted on road tankers or on transportable tanks for the transport and delivery of all liquids of low viscosity (less than or equal to 20 mPa·s) and stored at atmospheric pressure, with the exception of foaming potable liquids.

Note 1: tankers for liquefied gasses under pressure and tankers for potable liquids are not covered in Annex B – these tankers will be covered in future R 117-2 annexes.

Note 2: In accordance with Section 2.10.4 of R 117-1, higher viscosity liquids may be covered by Annex B, but are not required to have gas elimination devices fitted. In this case, provisions must be made to prevent the entry of air into the system.

B.1 General Information

Measuring systems on road tankers consist of several constituent elements. These constituent elements may or may not be subject to a separate type approval. According to 6.1.1 of OIML R 117-1, the constituent elements of a measuring system shall comply with the relevant requirements.

The type approval of a measuring system on a road tanker involves verifying that the constituent elements of the system, which have not been subject to separate type approvals, satisfy the applicable requirements.

Tests for carrying out the type approval of a measuring system on a road tanker shall therefore be determined on the basis of the type approvals already granted for the constituent elements.

When none of the constituent elements has been subject to separate type approval, all the tests provided in section 4, 5 and 7 shall be performed. On the contrary, when the various constituent elements are all approved separately, it may be possible to replace type approval based on tests by type approval of drawings of the constituent elements. This possibility has to be considered cautiously and it may be appropriate even if in this case to perform an accuracy test on the complete measuring system due to the possible influence of hydraulic conditions on the accuracy of the complete system.

Before conducting tests it is necessary to execute the design evaluation of the measuring system on a road tanker by using the general check-list given in R 117-3 and the relevant points for road tanker approval.

B.2 Testing procedures for meter sensors, measuring devices and meters with mechanical indicating devices

Testing is completed in accordance with Section 5. These tests include:

- Accuracy tests;
- Tests on the minimum measured quantity (with maximum specified hose length);
- Endurance testing; and
- Non-return valve configuration and reverse count detection.

B.3 Testing procedures for electronic devices: calculator, correction, indicating, and associated devices

Testing is completed in accordance with Section 6.

B.4 Testing procedures for gas elimination devices

Testing is completed in accordance with Section 7.

Note : if the measuring system is not fitted with a gas elimination device, the requirements of Sections 2.10 and 5.1.3 of R 117-1 shall be fulfilled.

B.5 Testing procedures for ancillary devices

Testing is completed in accordance with Section 8.

B.6 Additional testing procedures for the complete measuring system on a road tanker

B.6.1 Complete emptying of a compartment of a road tanker

Object of the test

To determine the effect of emptying a compartment of a road tanker during delivery on the accuracy of the quantity indication.

Test procedure

The test quantity shall be at least the quantity delivered in one minute at the maximum achievable flowrate ., rounded up to the volume of the test measure used.

(Q_{\max} is often impossible to achieve if the system has gravity delivery)

A compartment of a road tanker filled with the volume of the test measure used is completely emptied until the delivery is interrupted by the gas elimination device. The test shall be performed three times at the maximum flowrate of the measuring system.

1. Wet and drain the test measure.
2. Reset the indication of the CID.
3. Fill the test measure at Q_{\max} until the delivery is interrupted.
4. Read p_t and T_t at 50 % of the test volume.
5. Read V_i , V_s , T_s .
6. Calculate V_n and E_{vi} .
7. Drain the test measure.
8. Repeat steps 2 to 7 twice, and calculate the mean value \bar{E}_v .
9. Fill in test report n° XX

B.6.2 Connecting of an empty compartment

Object of the test

To determine the effect of connecting an empty compartment of a road tanker during delivery on the accuracy of the quantity indication.

Test procedure

The test shall be performed three times at the maximum achievable flowrate of the measuring system. The test quantity shall be at least the volume delivered in one minute at the maximum achievable flowrate.

The delivery starts from a filled compartment of the road tanker. After at least one minute an empty compartment is connected and the filled compartment is disconnected. After the delivery is interrupted by the gas elimination device the empty compartment is disconnected, the filled compartment is connected and the delivery is continued until the test measure is filled.

1. Wet and drain the test measure.
2. Reset the indication of the CID.
3. Start the filling procedure of the test measure from the filled compartment at Q_{\max} .
4. Read p_t and T_t .
5. Connect the empty compartment and disconnected the filled compartment.
6. After interruption of the delivery disconnect the empty compartment, connect the filled compartment and fill the test measure to its nominal volume.
7. Read V_i , V_s , T_s .
8. Calculate V_n and E_{vi} .
9. Drain the test measure.
10. Repeat steps 2 to 9 twice, and calculate the mean value \bar{E}_v .
11. Fill in test report n°XX.

B.6.3 Variation in the internal volume of the hose (full hose measuring systems only)

Object of the test

To determine the effect of the increase in internal volume of a hose under pressure on the accuracy of the quantity indication.

General information

The manufacturer may provide information on how the requirement in Section 2.15 of OIML R 117-1 is fulfilled. It may consist in providing the reference of the hose if it has been used previously in an approved measuring system or results of tests performed by the manufacturer of the measuring system or of the hose.

It shall then be verified that the hose is not used in worse conditions (pressure, length) than previously tested.

If the manufacturer is not able to provide this information, testing is necessary.

A hose is characterized by

- a) Manufacturer
- b) Designation
- c) Inner diameter
- d) Length of the hose
- e) The test report shall further contain data concerning
- f) Maximum operating pressure of the measuring system
- g) Minimum measured quantity of the measuring system

Test equipment:

A test installation, equipped with liquid supply, pressure source, a pressure gauge calibrated before the test, a graduated cylindrical glass tube of suitable capacity, valves and piping, as illustrated in Figure 3. Alternative test installations with similar performance may be used.

Test procedure (See figure 3):

- 1 All valves should be closed before test.
- 2 Connect the hose in position on the test installation
- 3 Open valves V_A , V_B and V_C , and fill the pressure source, the hose and the glass tube with liquid. Partially open valve V_D and allow the liquid to run from the tank through the glass tube until no air bubbles are seen in the glass tube. Then close all valves.
- 4 Open valve V_D , and adjust the liquid level to an appropriate position. Then close valve V_D , and read level X .
- 5 Open valve V_B . Adjust the pressure source until the reading of the pressure gauge is stable at the maximum operating pressure of the fuel dispenser
- 6 Close valve V_B .
- 7 Open valve V_C , and read level Y .
- 8 Calculate $Y - X$.
- 9 Close valve V_C .
- 10 Repeat steps 4 to 9 twice.
- 11 Calculate the mean value of $Y - X$.
- 12 Fill in test report n° XX

B.6.4 Complete emptying of the hose (empty hose measuring system only)

Object of the test

To determine the effect of the repeatability of the complete emptying of the hose by using additional devices or by gravity on the accuracy of the quantity indication.

Test procedure

The test shall be performed three times at a flowrate within the flowrate range of the measuring system. The test quantity shall be the minimum measured quantity. Information on the complete emptying procedure shall be fully documented in the test report.

1. Wet and drain the test measure.
2. Reset the indication of the CID.
3. Fill the test measure.
4. Read p_t and T_t at 50 % of the test volume.
5. Empty the hose in accordance with manufacturers instructions.
6. Read V_i , V_s , T_s .
7. Calculate V_n and E_{vi} .
8. Drain the test measure.
9. Repeat steps 2 to 8 twice, and calculate the mean value \bar{E}_v .
10. Fill in test report n° XX

Annex X

Interpretation, Examples, Advice, and Possible Solutions

X --- Chapter 5 (Testing procedures for meter sensors and measuring devices)

X.5.1 If the meter sensor/measuring device is tested in a complete fuel dispenser (especially at lower flowrates), a temperature rise during the successive tests can occur. To avoid such a temperature rise, a connection with a non-return valve and flow regulating valve from the pipe between the gas separator and the meter sensor, measuring device or meter to the supply tank can be installed. At lower flowrates, the main liquid flow is fed back to the storage tank via this extra outlet.]

Every time the meter sensor/measuring device to be tested is connected hydraulically, it should be operated at the maximum flowrate for at least five minutes (e.g. to reach stability of [liquid] temperature and removal of air/gas) before measurement starts. Every time a new work session starts (for example after a stop of one hour or more), the EUT should operate at the maximum flowrate for at least one minute or until metrological stability is achieved, before the measurement starts.

X.5.3.4 Advice on Flow disturbance Section 5.3.4

A few disturbance configurations are provided in the case that flow disturbance testing is performed:

- two elbows in the same plane upstream of the meter or the measurement transducer;
- two elbows in the same plane upstream of the meter or the measurement transducer and two elbows in the same plane upstream of the meter or the measurement transducer;
- a locked propeller upstream of the meter or the measurement transducer;
- a locked propeller downstream of the meter or the measurement transducer,
- a valve upstream of the meter or the measurement transducer in several positions (90°, 80°, 65°, 45°).

If necessary, additional disturbance configurations may be defined by the technology of the meter.

X.5.4 Determination of flowrate

The flowrate can be obtained under flying start/stop conditions by the following procedure:

- 1 Start the flow. ~~rate~~. When the indication is at a whole number of litres/kg (V1), start the stop-watch.
- 2 After at least 30 seconds, stop the stop-watch when the indication is at a whole number of litres or kilograms (V2).
- 3 Calculate the flowrate $Q = (V2 - V1) \times (60 / t)$ in L or kg/min

(Where: t = the time elapsed in seconds, from the stop-watch in step 3.)

X.5.4.3 advice section X.5.4.3

	P.D.	Turbine	Mass Flow	Ultrasonic	Mag	Other	Y = yes N = no TBA = to be assessed
Temp amb	n	n	y	n	n	tba	
Temp Liq	n*	n*	y	n	n	tba	
Pressure Liq	n	n	y	n	n	tba	
Reynolds/Viscosity	y	y	y	y	y	tba	
Density	n	n	y	n	n	tba	
Conductance	N	N	N	N	y	tba	
Orientation	y	y	y	n	n	tba	
Flow Profile (disturbed)	n	y	y	y	y	tba	
Zero Flow	n	n	y	y	y	tba	
External Vibration (in use)	n	n	y	n	n	tba	
Endurance	y	y	n	n	n	tba	

Table showing the whether the meter technology is affected by various operating conditions

*unless outside the prescribed range (normal use)

external vibration in use

X.5.4.3 (continued)

Testing at the limits of the rated operating conditions may not be required when these limits have a negligible effect on the specific meter technology. (For example, it would not be necessary to test a mass flow meter at the limits of viscosity, or a meter with a pressure-balanced measuring chamber at the limits of pressure).

When it is determined that the rated operating conditions will affect the accuracy of the meter, the following may be considered:

- tests at the limits of pressure are not needed if the maximum liquid pressure is equal to or below 10 bar;
- tests at the limits of pressure may be conducted within ± 10 bar of the actual limit;
- tests on a liquid with a viscosity up to 1 mPa·s may be used to represent liquids with viscosities up to 2 mPa·s;
- tests at the limits of viscosity > 2 mPa·s may be within ± 20 % of the actual limits;
- tests at the limits of liquid density may be within ± 100 kg/m³ of the actual limits.

Where the measuring system is intended to measure liquid quantities at temperatures from -5 °C to $+35$ °C, only one accuracy test at one temperature between -5 °C and $+35$ °C is suggested.

X.5.7 Advice on Section 5.7

Advice/Remarks:

- Please note that plain water will freeze during a test on low temperatures, in which case the EUT would no longer operate normally.
- To prevent damage to the flowsensor due to temperature expansion or contraction, do not close the sensor by means of rigid blinding flanges.
- Also keep in mind that in some liquids, bubbles will appear for example by dissolving air. Especially when testing ultrasonic flowmeters, this could cause ultrasonic signals to be interrupted, which is an undesired effect.
- Before the temperature of the liquid is fully stabilised, temperature convection will cause small flows of liquid to move up and down through the EUT. On some meters this will appear as a flow indication where none is expected.

Advice on 5.7 Test Method Influence test type A

Calculation example:

Flowrate under reference conditions: 0.0400 L/min

Flowrate under test conditions: 0.0500 L/min

Flowrange to be tested: 5 – 100 L/min

Change in flowrate: $0.05 - 0.04 = 0.01$ L/min

$(0.01 / 5) * 100\% < 0.3\%$

$0.2\% < 0.3\% \rightarrow$ O.K.

Precautions for EUT's with installation dependent characteristics:

Some measurement characteristics may to some degree be affected by the way an electronic meter is installed in a system (the zero-setting of a Coriolismeter for example).

When this is the case, care must be taken that the EUT is not moved nor its installation changed between the reference test and the other tests.

Ambient temperature tests for ultrasonic flowmeters:

Possibly, ultrasonic flowmeters are fitted with an internal temperature transmitter to perform corrections for changes in the meter body's dimensions due to temperature expansion / contraction. Based on information provided by the manufacturer and/or knowledge of physics, it should be checked by calculation which part of the observed changes, can be contributed to changes in the dimensions of the EUT and which is caused by effects on the EUT's electronics for which these tests are intended.

Ambient temperature tests for electromagnetic flowmeters:

If equipped with a temperature transmitter for corrections, the same applies as for the ultrasonic flowmeters.

Ambient temperature tests for Coriolismeters:

Most Coriolismeters are equipped with an internal temperature transmitter for the purpose of correction. Due to changing measurement tube temperature, the EUT's characteristics will change during the ambient temperature tests. To test the effects on the EUT's electronics separately, this mechanical effect can be eliminated. When one pick-off coil is connected in parallel to both applicable inputs, the mechanical effect of temperature changes is eliminated.

Advice on 5.7 Test Method Influence test type B

For precautions, see Influence tests type A.

Advice to chapter 5 concerning meter types:

Low-Flow-Cut-off

Possibly in electronic meters a so-called low-flow-cut-off is installed. This feature will consider flowrates below this value not be a measurement. Once a flowrate higher than this value is registered, will the flowrate (without subtraction of the low-flow-cut-off value) be registered as a measurement. During testing, in most cases, it is desirable to see all flow indications, even if below the normal low-flow-cut-off value. Therefore, during most performance tests the low-flow-cut-off should be set to zero.

Please note that in practice an indication other than zero is needed during testing. Generally the value in practice depends on the zero-stability of the meter, the minimum measured quantity of the complete measuring instrument / system and the application itself.

Meter curve, electromagnetic flowmeters

Meter performance of an electromagnetic flowmeter is typically determined by the electric conductivity of the liquid and the flow profile.

Meter curve, ultrasonic flowmeters

Several effects determine the metrological behaviour of ultrasonic flowmeters:

The acoustic damping of the liquid:

If the amplitude of the signal decreases too much, the signal to noise ratio becomes so small that the measurement signal becomes unreliable.

The flow profile of the liquid through the measurement sensor:

From the speed of the liquid through the measurement paths, the average flowrate is determined. This is done by applying a weighing factor to the liquid speeds measured through particular paths. If these do not represent the actual flow profile, an incorrect flowrate is determined.

The Reynolds number:

Basically an ultrasonic flowmeter is a Reynolds dependent device. The combination of the sensor's inner diameter, the average speed of the liquid, the liquid density and the liquid viscosity determine the Reynolds number. Therefore the operating range of an ultrasonic meter can be given as the ranges of each of these factors or as a Reynolds range.

Gas bubbles and solid particles:

Both gas bubbles and solid particles contained within the liquid affect the meter's performance due to the fact that they disturb/reflect the ultrasonic signal. Moreover, if the signal is not disrupted, the volume of gas bubbles will be attributed to the liquid volume. However, when the signal is disrupted by gas bubbles or solid particles, this can be detected by an ultrasonic meter. Detection of such events can be followed by a correcting action, such as for example stopping the flow. If the flow is interrupted quickly enough, the effect of gas bubbles and/or solid particles can be reduced to acceptable proportions. The sensitivity of an ultrasonic meter to gas bubbles and/or solid particles will depend on many factors. Therefore, specific tests would need to be done to prove that effects are within acceptable limits.

Meter curve, Coriolis meters

Typically liquid density and/or liquid pressure may have an effect on the device's metrological characteristics. Possibly, effects are automatically corrected for, but in some cases the meter curve may need to be determined under pressures and/or on liquids of a similar density and/or pressure as present in the end-application.

If it is proven during a type approval, that the effects given above are negligible or properly corrected for, a Coriolismeter's curve can be determined on a liquid which is not similar to the one in the end-application. In that case a meter curve determined on water could for example suit an application on LPG.

Installation effects on Coriolismeters:

The meter's installation dependent zero setting affects the metrological behaviour of the device. Therefore it must be checked that the zero setting is correct, once the device is installed. The documentation, manuals, Type approval certificate must state when zero setting must be performed (for example when the installation has been disturbed, change of liquid, change of temperature).

Coriolis sensor:

All Coriolismeters basically consist out of two sensors: one flowsensor (usually consisting out of one or two parallel measurement tubes) and a temperature sensor for the benefit of performing temperature corrections on the vibrational properties of the flowsensor.

The primary measurement signals of a Coriolismeter are the following:

- a time difference related to the mass flowrate through the flowsensor
- a resonant frequency related to the density of the liquid in the flowsensor
- a resistance related to the temperature of the measurement tube(s)

The measurement tube(s) is/are set into motion (a sinusoidal vibration) by means of an alternating current through one or more so-called drive coils. The movement of the measurement tubes is detected using at least two pick-off coils. In principle these coils are considered to be electronic components, thus making a Coriolis flowsensor an electronic device, on which the applicable performance tests need to be performed. However, the measurement tubes themselves are purely mechanical components. Only when it is proven that these coils are sufficiently insensitive to the effects of the test conditions, is it allowed not to submit the Coriolis flowsensor to influence/disturbance tests.

Density measurement:

In principle all Coriolismeters perform both a mass flowrate and a density measurement. Both the mass and/or the volume of liquid can be the bases for the measurement transaction. If so desired by the applicant, both the mass and volume output of the equipment under test can be tested against legal requirements. In the case of a Coriolismeter, volume is calculated from measured mass and measured density. So once it is determined that the calculation of volume operates correctly, verification of the mass and density determination suffices to guarantee the correctness of the Coriolismeter's mass and volume outputs.

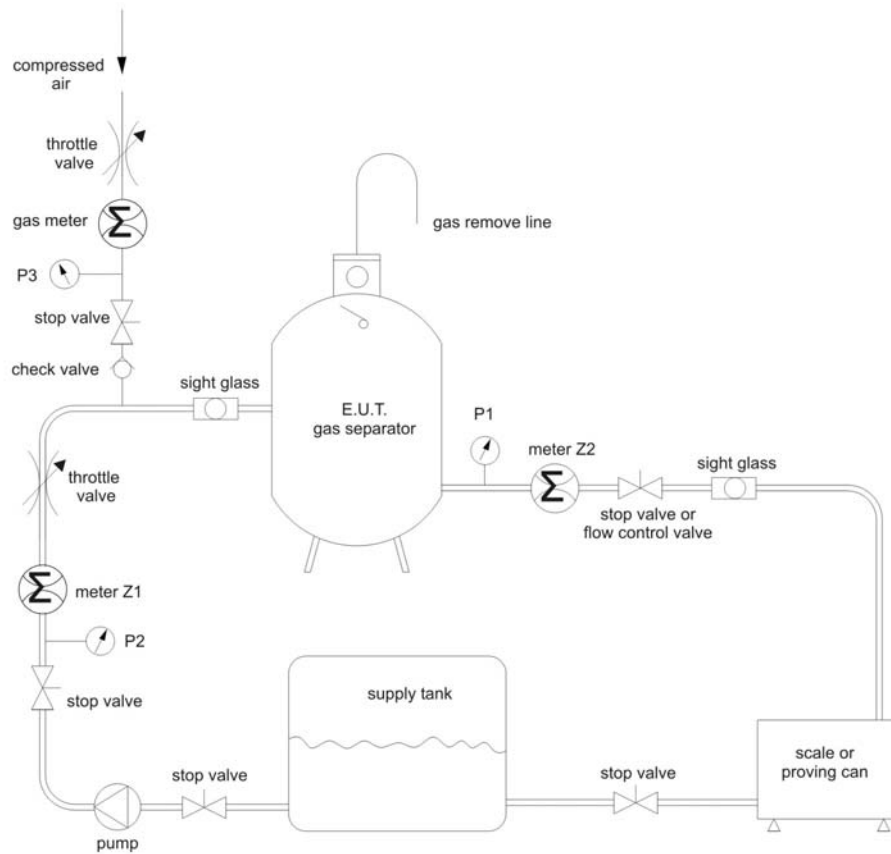
Effect of liquid properties:

Some Coriolismeters may be affected by the density of the measurand, in which case the meter curve will shift dependent of the liquid density.

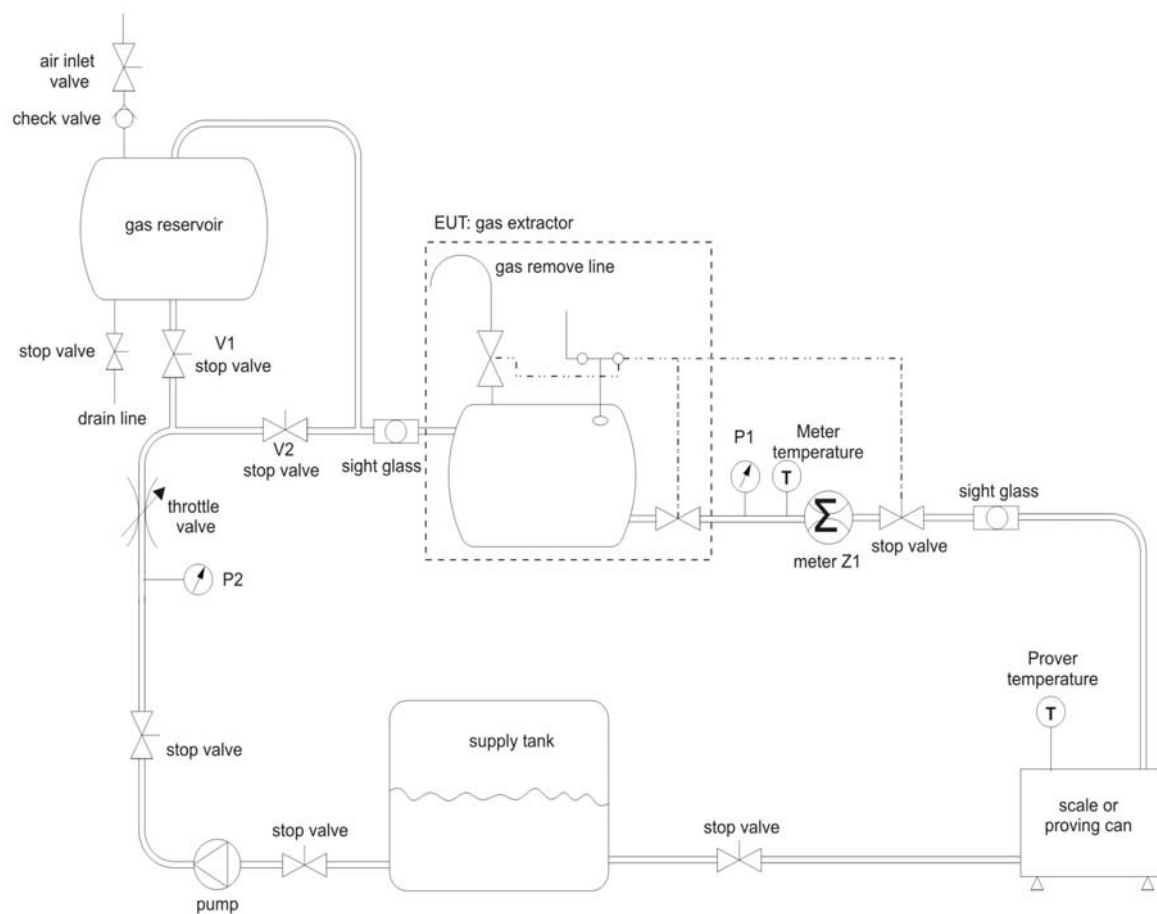
Extremely high liquid viscosities also may have an effect. This is thought to be caused by the liquid absorbing the vibrational energy of the measurement tubes, thus reducing the amplitude of the vibration. In extreme cases such a reduction will cause the measurement signals to become too small for correct processing. Such effects occur especially when the flow is started.

X.7 Advice Annex for Section 7 “Test Procedures for Gas Elimination Devices”

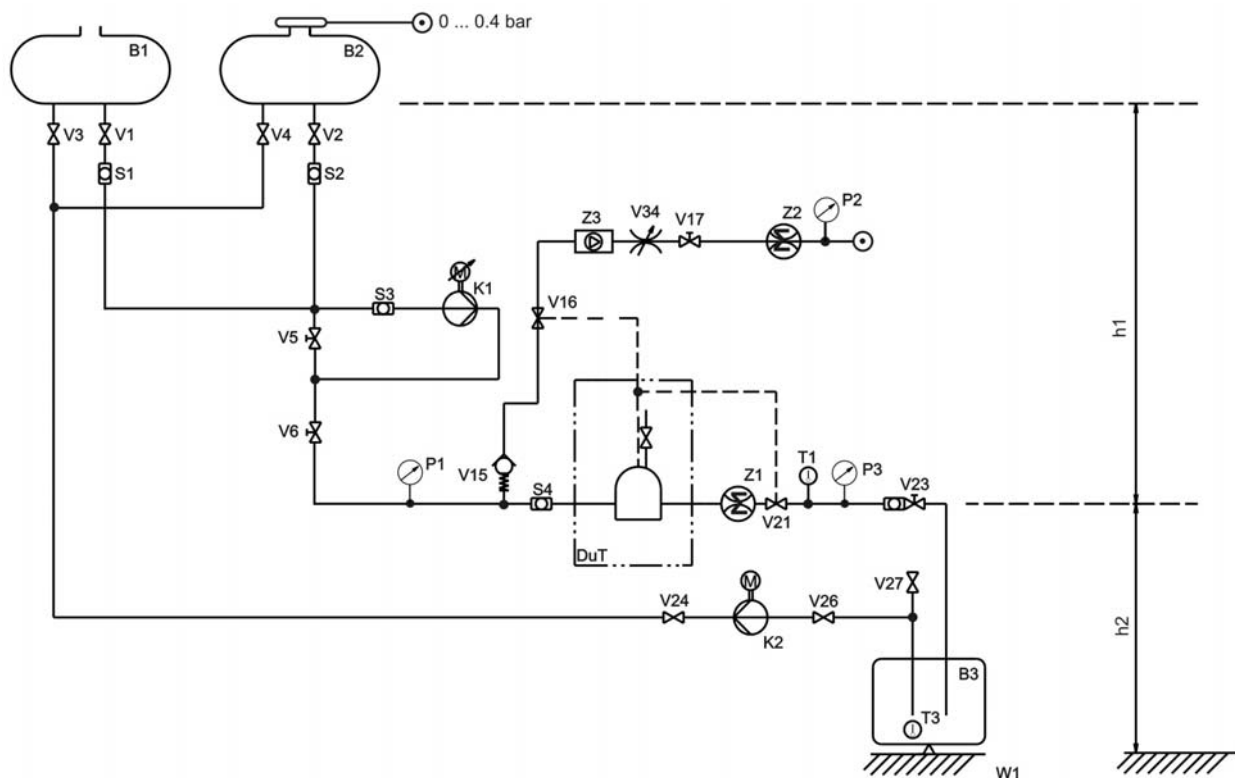
X.7.4



X.7.4 Figure 1: gas separator test stand



**X.7.4, Figure 2: Air pocket test bench for refinery applications
(the volumetric prover could also be a gravimetric scale)**



X.7.4, Figure 3: Layout of the special gas extractor test bench

No.:	Component	Name
1	Storage tank	B2, B1
2	Test container	B3
3	Foot valve	V2, V1
4	In-line valve	V4, V3
5	Stop valve	V5, V6, V21, V16
6	Ball valve	V17
7	Check valve	V15
8	Throttle valve with sight glass	V23
9	In-line valve	V24, V26, V27
10	Throttle valve	V34
11	Sight glass	S1, S2, S3, S4
12	Pressure manometer	P1, P3
13	Thermometer	T2, T1
14	Pump	K1, K2
15	Scale	W1
16	Positive displacement meter	Z1
17	High pressure gas meter	Z2
18	Rotameter	Z3

X.7.4, Table 1: System components of the test bench

X.A.6.1 Flow interruption – with maximum specified hose length (this test is only applicable for fuel dispensers with mechanical calculators)

Advice on a detailed procedure that can be used to meet the testing requirement of A.6.1.

- 1 Set the maximum unit price, if applicable.
- 2 Wet and drain the test measure.
- 3 Reset the indication of the CID.
- 4 Fill the test measure at Q_{max} , with 5 stops.
- 5 Read p_t and T_t at 50 % of the test volume.
- 6 Read V_i , V_s , T_s and P_i , if applicable.
- 7 Calculate V_n and E_{vi} , and if applicable P_c and E_{pi} .
- 8 Drain the test measure.
- 9 Repeat steps 3 to 8 twice, and calculate the mean values \bar{E}_v and \bar{E}_p .
- 10 Fill in test report number _____ (R 117-3).

X.A.6.2 Testing procedures advice related to fuel dispenser hose dilation

Test of hose dilation:

- Step 1) de-mask hose dilation masking at calculator
- Step 2) lift nozzle and do not pull trigger (no flow) – display should zero and pump start
- Step 3) wait for system to pressurize (pump starts or submerge pump started, hose has a small move while pressure builds-up)
- Step 4) check display after 30 seconds and read display
- Step 5) check that registered quantity is less or equal to MPE for MMQ
- Step 6) hang nozzle
- Step 7) engage hose dilation masking at calculator
- Step 8) lift nozzle and wait for pressurization
- Step 9) in can, pull trigger slowly, and wait for first change on volume display to stop flow.
- Step 10) First change must correspond to hose dilation masking, and should not be more than MPE for MMQ

X.A.6.3 Other fuel dispenser functionality to be tested:

- Functional test of communication protocols,
- Temperature compensation, (Temperature measurement, position of probe)
- Electronic calibration.

It must be possible, without breaking a seal, to disable the masking function to allow:

- verification of hose inflation volume;
- reduction of measuring errors during verifications (assessing hose inflation contribution);
and
- checking that the device incorporated at the free end of the hose prevents the draining of the hose during shutdown periods as per R 117-1 Section 2.13.6.

When temperature correction system is associated to a fuel dispenser, it must be possible to disengage the system temporarily, without breaking a seal, to allow verifications of the measuring system. Such operating mode must be limited to one measurement and software system must fallback into normal temperature correction mode at next reset of indication.

Note: display must indicate (eg: by blinking, or using special indication) that the measuring system is operating without temperature correction, only for calibration purpose.

Annex X.10

Additional R 117-2 Advice Figures

Figure 1: Test installation for gas separators in fuel dispensers

Figure 2: Test installation for gas extractors

Figure 3: Test apparatus for variation in the internal volume of the hose

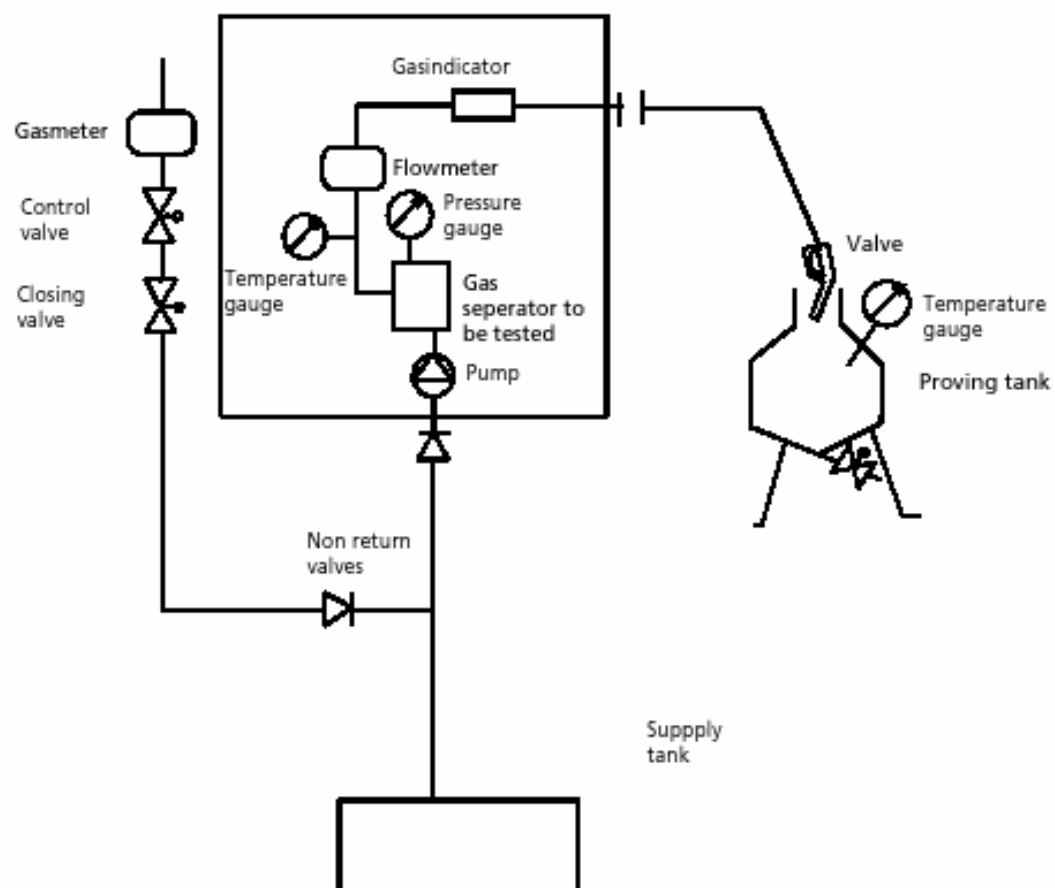


Figure 1 - Test installation for gas separators in fuel dispensers

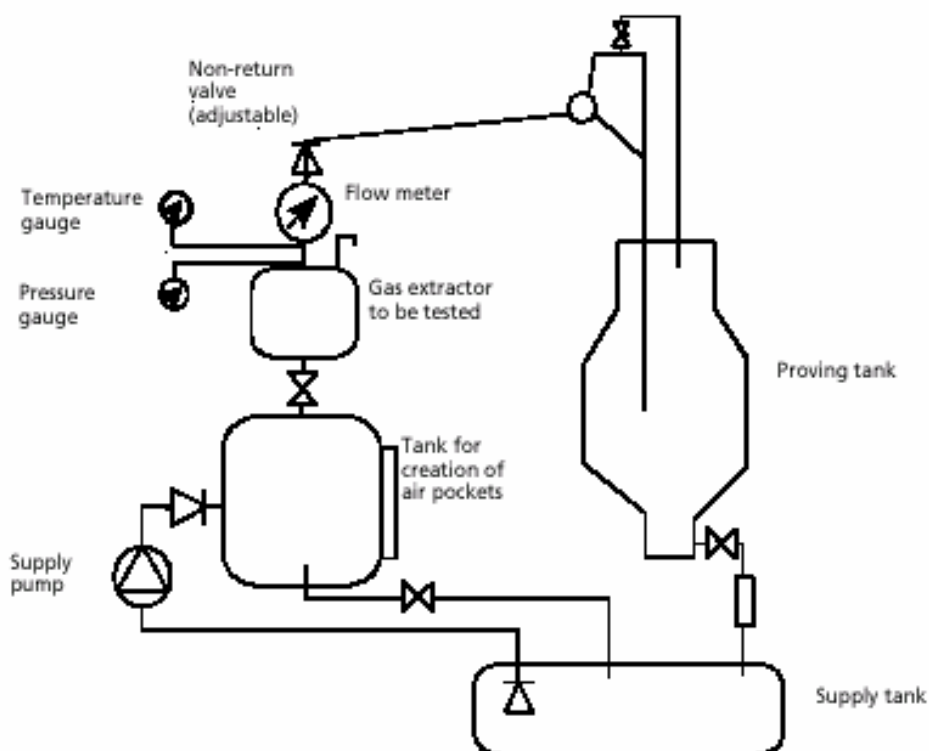


Figure 2 - Test installation for gas extractors

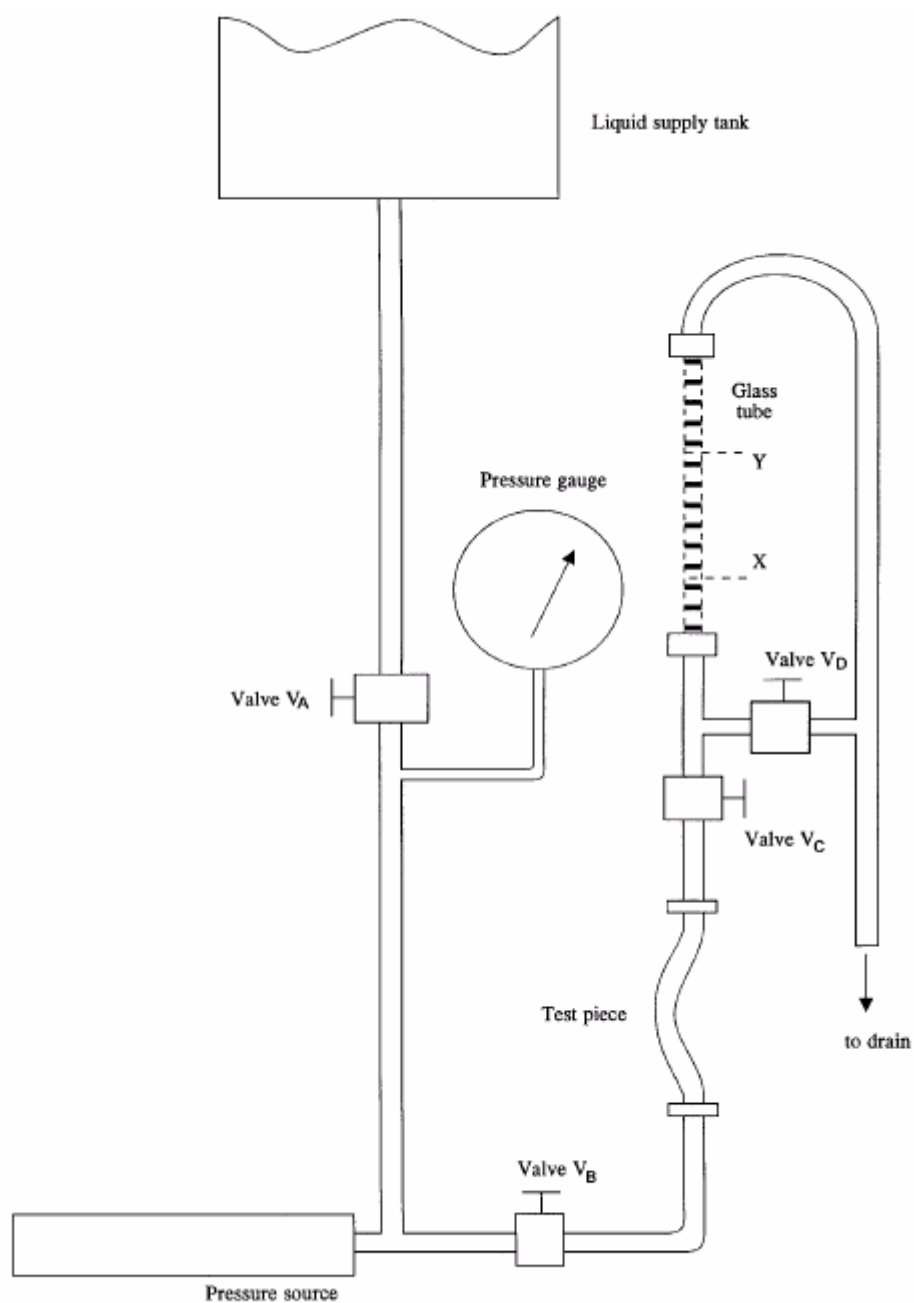


Figure 3 Test apparatus for variation in the internal volume of the hose

Annex X.11

Section from R 117-1	General metrological requirements for <u>specific components</u> of a measuring system																	
	Meter					Gas elimination device			Associated measuring devices			Ancillary device (main examples)						
	Measuring device				Electronic calculator (incl. conversion, adjustment, correction)	Indicating device	Gas separator	Gas extractor	Special gas extractor	Pressure measuring device	Density measuring device	Temperature measuring device	Self-service device	Printing device	Memory device	Price indication device	Pre-setting device	Conversion device (not included in calculator)
	Meter sensor		transducer															
	electrical	mechanical	electrical	mechanical														
1.2	X	X																
2.2													X	X	X	X	X	X
2.5	X	X	X	X	X	X												
2.6.2	X	X	X	X	X	X				X	X	X						
2.6.3	X	X	X	X	X	X												
2.7.1					X					X	X	X						X
2.7.2					X					X	X	X						X
2.8					X													
2.9.1						X				X	X	X						
2.9.2						X												X
2.10.1							X	X	X									
2.10.2							X	X	X									
2.10.3							X	X	X									
2.10.5							X	X	X									
2.10.7							X	X	X									

Section from R 117-1	General metrological requirements for <u>specific components</u> of a measuring system																	
	Meter						Gas elimination device			Associated measuring devices			Ancillary device (main examples)					
	Measuring device				Electronic calculator (incl. conversion, adjustment, correction)	Indicating device	Gas separator	Gas extractor	Special gas extractor	Pressure measuring device	Density measuring device	Temperature measuring device	Self-service device	Printing device	Memory device	Price indication device	Pre-setting device	Conversion device (not included in calculator)
	Meter sensor		transducer															
	electrical	mechanical	electrical	mechanical														
2.10.8						X												
2.10.9								X	X									
2.19.2	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2.19.4						X												
2.20.1	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2.20.2					X	X							X		X			X
3.1.1	X	X	X	X	X	X												
3.1.2	X	X	X	X	X	X												
3.1.3			X	X	X													
3.1.4			X		X					X	X	X						
3.1.5		X	X	X	X	X												
3.1.6	X		X		X	X												
3.1.7	X		X		X	X												
3.1.8	X		X		X	X												
3.1.9	X		X		X	X												
3.1.1																		

Section from R 117-1	General metrological requirements for <u>specific components</u> of a measuring system																	
	Meter					Gas elimination device			Associated measuring devices			Ancillary device (main examples)						
	Measuring device				Electronic calculator (incl. conversion, adjustment, correction)	Indicating device	Gas separator	Gas extractor	Special gas extractor	Pressure measuring device	Density measuring device	Temperature measuring device	Self-service device	Printing device	Memory device	Price indication device	Pre-setting device	Conversion device (not included in calculator)
	Meter sensor		transducer															
	electrical	mechanical	electrical	mechanical														
3.2					X													
3.3																X		
3.4														X				
3.5															X			
3.6																	X	
3.7																		X
3.8					X													
4.1	X		X		X	X												
4.2					X	X												
4.3.1	X		X		X	X								X				X
4.3.2	X		X															
4.3.3					X								X		X? ?			
4.3.4						X												
4.3.5													X	X	X	X	X	X
4.3.6										X	X	X						