Committee DRAFT OIML/2CD R139-1

Date: 21 December 2012

Reference number: TC 8/SC 7/P4/N050/2CD

Supersedes document: TC8/SC7/035/1CD (1CD R139-1)

OIML TC8 / SC7

Title: **Project p4**

Draft Revision OIML R 139
Compressed gaseous fuel measuring systems for vehicles

Secretariat: The Netherlands

Circulated to P- and O-members and liaison international bodies and external organizations for:

☐ discussion at (date and place of meeting):.....

☐ comments by:

☒ vote (P-members only) and comments by 25 March 2013.....

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TITLE OF THE CD (English):
OIML R 139-1
Compressed gaseous fuel measuring systems for vehicles
Part 1: Metrological and Technical Requirements

TITRE DU CD (French):
OIML R 139-1
Ensembles de mesurage de gaz compressé pour véhicules
Partie 1: Exigences métrologiques et techniques,

Original version in: English

Explanatory note

Temporary section to be removed after finalization of the Recommendation

The first edition of this OIML Recommendation was approved by CIML in their meeting in October 2007. And at the same time it was agreed to start a revision.

During the OIML seminar in April 2008 for TC/SC secretaries, a (draft) general format for OIML Recommendations was presented. And in his letter BIML 08 No. 344/RG/JFM, dated 8 July 2008, the Director of the BIML encouraged the secretaries of the TC's and SC's to already use this (draft) format when starting a new project (i.e. when drawing up a new OIML Recommendation or revising an existing one). See also OIML Bulletin July/October 2008, page 36. And as the secretary of OIML TC8/SC7 fully supports that concept in order to improve the coherence of all OIML Recommendations, the first step in revising R 139 is changing the structure of R 139 to a great extent in accordance with this format.

As a result, a few requirements of general relevance were added, editorial changes were made, and some inconsistencies were solved. As the requirements shall be as far as possible independent of the applied technology, the text is often modified in such a way that "electronics" are not regarded as something special. And the order of the subjects has been completely changed: In accordance with the format, this draft has been split in 2 distinctive parts: Part 1 with the requirements (without any test, contents of type approval certificate, etc.) and Part 2 dealing with the tests and other Metrological control (without any "hidden" requirement). By decision of the BIML, these two Parts will preferably be published together in one "book" (PDF-file).

Furthermore, it was identified that, although [1] in the Bibliography refers to edition 2007 of the "VIM", the definitions were in accordance with the old edition of the VIM. But, as it is stated in the introduction of the Terminology: *"The terminology used in this Recommendation conforms to ... VIM ...and ... VIML."*, it is the secretary's opinion that it is superfluous repeating such definitions and they have been removed.

In the 1WD, it was not yet the intention of the secretary to include basic technical changes in the requirements. The application of the general format also resulted in some new (mostly obvious) requirements and considerations. These are marked in blue as "New". And, following the latest version of OIML R 117 (2007), two new test for instruments powered by DC mains networks have been added: *"DC mains voltage dips, short interruptions and voltage variations"* and *"Ripple on DC mains power"*; this is also in compliance with OIML D 11 (2004).

It seems that in the edition 2007, some wordings in the description of the tests were copied from a draft of OIML D 11. In the meantime OIML D 11 (2004) was published. So these texts are aligned now with the present version of D 11.

Concerning possible technical changes, a questionnaire was distributed together with the 1 WD. Items that needed special attention were highlighted yellow.

The results of the voting on the questions was implemented as much as possible in this 2WD and discussed in a WG meeting in 2010 in Delft. The results of the meeting were implemented in the present 1CD

As a result of the changes towards the "general format", there are so many editorial changes and changes in the sequence of the text that, according to the opinion of the secretary, that it made no sense to provide a marked version. Nevertheless, a few of the characteristic editorial changes were marked in the text. But instead, references to the text in edition 2007 were temporary added in blue between brackets and a few references to the draft format were temporary added in green. Furthermore, a temporary transposition table from the old text to the new draft was added as a part of this Explanatory Note. It was foreseen that these temporary blue and green references and the transposition tables would be deleted in the next Working Draft. In the 1 and 2 CD however the new secretary decided to keep these coloured references until it has been decided by the SC that the references do not serve any further purpose.

In the opinion of the secretary, there is no need to have separated clauses for radio frequency electromagnetic fields "of general origin" and "caused by digital radio telephones" (the requirement for both being 10 V/m with the same modulation). Therefore, these clauses were combined.

This 2CD (part 1 and part 2) was amended on basis of the comments received on the 1CD (part 1 and part 2) which have been combined and reflected upon in the documents TC 8/SC 7/P04/N041_CC_03 and TC 8/SC 7/P04/N042_CC_03 available on the TC 8/SC 7 p4 website pages. During November 2012 a number of members discussed in an international work group meeting the most critical topics dealt with in these comments.

Transposition of OIML R 139 (2007) into this Committee Draft

Temporary section to be removed in later Drafts

(Mainly clauses 1 - 7) => **Part 1**

Old Clause	New Clause
Terminology	3
-	1
1	2
2.1	4.1, 4.2
2.2.1	13.1
2.2.2	13.2
2.2.3	13.3
2.2.4	6.14.1
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2.3.2	5.3.2
2.3.3	5.3.1
2.4.1	6.2.1
2.4.2	5.1.1
2.4.3 + 2.4.4	5.1.5
2.4.5	6.2.2
2.4.6	5.1.4
2.4.7	6.2.3
2.5.1	14.1
2.5.2	6.14.2
2.5.3	14.2
2.5.4	14.3
2.5.5	6.14.3
2.5.6	6.14.4
2.5.7	6.14.5
3.1.1	5.2.1 + 8.2, u) + Part 3
3.1.2	5.2.3
3.1.3	5.2.4
3.1.4	5.2.5
3.1.5	5.4.1
3.1.6	5.4.2
3.1.7	5.8.2 + 5.4.3
3.2.1	5.2.2
3.2.2	17.2.2
4.1.1	15.1.1 + 5.5.2, a) + b)
4.1.2	-
4.1.3	15.1.2.1
4.1.4	15.1.2.2
4.1.5	15.1.2.3
4.2.1	6.2.1
4.2.2	6.2.4
4.2.3	5.1.3
4.3	6.5
4.3.1	6.5.1
4.3.2	6.5.2
4.3.3	6.2.8.1
4.3.4	6.5.3
4.4	6.2.7
4.5	6.2.8
4.5.1	5.1.1
4.5.2	6.2.8.2
4.5.3	6.2.8.3
4.5.4	6.2.8.4
4.5.5	6.2.8.5
4.6	6.3
4.7	6.6
4.8	6.7
5.1.1	5.5.2
5.1.2	5.7
5.1.3	5.8.1
5.1.4	12
5.2	6.8
5.3	6.10
6	6.12
7.1	7
7.2.1	9.1 + 10
7.2.2	9.2

(Mainly clauses 8 - Annex D) => **Part 2**

Old Clause	New Clause
2.3.4	16.2.4
8 (1st para)	16.3
8.1.1	17.1.3
8.1.2	18.2
8.1.2.1 & -.2	18.2.1
8.1.3	Part 3
8.1.4	16.2.3
8.1.5	18.11.1
8.1.6	18.11.2
8.1.7	18.11.3
8.1.8	17.2
8.1.9	-
8.1.9.1	17.1.1
8.1.9.2	5.5.2 + 5.7
8.1.9.3	17.2.2
8.2.1	19.3 +19.6.3.1
8.2.2.1	19.4
8.2.2.2	8.3
8.2.2.3	-
8.3	20
A.1	18.8
A.2	5.5.1 + 8.2 + 7.1
A.3	18.7.2
A.4	18.8
A.4.1	18.8.2.1
A.4.2	18.8.2.2
A.4.3	18.9.1
A.4.4	18.8.3
A.4.5	18.9.2.1
A.4.6	18.9.2.2
A.4.7	18.9.3
A.4.8	18.9.4.2
A.4.9	18.8.4.2
A.4.10	18.8.4.1
A.4.11	18.9.5
A.4.12	18.9.7
A.4.13	18.9.4.1
A.4.14	18.8.5
Ann. B (intro)	17.2.4
B.1	17.2.4.2
B.2	17.2.5
B.3	18.3
B.4 (intro)	19.6.3.2
B.4.1	19.6.5
B.4.2	19.6.6
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Contents

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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:

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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 CIML. Thus, they do not necessarily represent the views of the OIML.

This publication - reference OIML R 139-1 & -2, Edition 201x - was developed by Technical Subcommittee TC8/SC7. It was approved for final publication by the International Committee of Legal Metrology in 201x and will be submitted to the International Conference of Legal Metrology in 201y for formal sanction. It supersedes the previous edition of R 139 (2007).

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Compressed gaseous fuel measuring systems for vehicles
Part 1 - Metrological and technical requirements

1 Introduction (New)

Significant technical changes from the previous edition:

The order of the subjects and the wordings of the articles have been changed to a great extent towards the general template for OIML Recommendations. This resulted in a strict separation between the requirements (Part 1) and metrological controls and performance tests (Part 2).

This OIML Recommendation consists of 3 parts:
Part 1: Metrological and Technical Requirements;
Part 2: Metrological Controls and Performance Tests;
Part 3: Report Format for Type Evaluation (to be published later).

Parts 1 and 2 are in this combined publication and Part 3 of the Recommendation *"Report Format for Type Evaluation"* will be published separately.

Publication of all three Parts is necessary to cover the applicability OIML R 139 in the OIML Certificate System and in the framework of the OIML Mutual Acceptance Arrangement (MAA).

2 Scope (1)

Part 1 of this OIML Recommendation specifies the metrological and technical requirements applicable to compressed gaseous fuel measuring systems for vehicles.

Part 2 provides guidelines for the type evaluation of the measuring systems and their constituent elements (modules like meter, etc.), as well as for the initial and subsequent verification.

In general, the measuring systems that are covered by this recommendation are intended for the refueling of motor vehicles, small boats, and aircraft with compressed natural gas, hydrogen, biogas, gas blends or other compressed gaseous fuels. Application to other vehicles, for instance trains, are also possible.

Measuring systems for liquid petroleum gas are beyond the scope of this Recommendation. These are within the scope of OIML R 117, which covers fluids in a liquid state.

In principle, this Recommendation applies to all measuring systems fitted with a meter as defined in 3.1.2 **(T.1.1)** (continuous measurement), whatever the measuring principle may be of the meters or their application.

This Recommendation is not intended to prevent the development of new technologies. According to the state of the art, this Recommendation is intended for measuring systems providing mass indications.

Note:

Although the metrological requirements concerning the measuring of gases within the scope of this Recommendation is independent of the type of gas, the testing methods for verification of compliance as described in Part 2 may differ where necessary for the different gasses..

3 Terminology (T)

Unless otherwise stated in the following sub clauses, the terminology used in this Recommendation conforms to OIML V 1 *International Vocabulary of Basic and General Terms in Metrology* (VIM) [1], to OIML V 2 *International Vocabulary of Terms in Legal Metrology* (VIML) [2], to OIML D 9 *Principles of metrological supervision* [3], to OIML D 11 *General Requirements for electronic measuring instruments* [4], and to OIML B 3 *OIML Basic Certificate System for Measuring Instruments* [5].

In addition, for the purposes of this Recommendation, the following definitions apply.

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3.1 (T.1) Measuring system and its constituents

3.1.1 (New) device

distinctive part of a measuring instrument or measuring system performing a specific task.

Note 1: A device can either be a physical part or concern a function (for instance in the software).

Note 2: A "facility" can also be regarded as a device in accordance with this definition (see also note 4.2.4).

3.1.2 (T.1.1) meter

instrument intended to measure continuously and display the total value of the quantity of gas passing through the measurement transducer at metering conditions.

Note : A meter includes at least a measuring device, a calculator (including adjustment or correction devices if present) and an indicating device (see figure 1)

3.1.3 (New) measuring device

part of the meter converting the flow, the volume or the mass of the measurand into signals representing the measured quantity required as input for the measurement calculator, comprising a sensor and a transducer.

3.1.3.1 (New) measurand quantity sensor or sensor

part of the measuring device, directly affected by a measurand quantity parameter producing input signal for the transducer.

3.1.3.2 (T.1.2) measurement transducer or transducer

part of the measuring device that provides an output signal representing the measured quantity based on the input from the sensor(-s).

3.1.4 (T.1.3) calculator

3.1.4.1 (T.1.3.1) metering calculator

part of the meter that receives the output signals from the transducer(s) and, possibly, from associated measuring instruments, transforms them and, if appropriate, stores in memory the results until they are used.

3.1.4.2 (T.1.3.2) operational calculator

optional part of the meter that receives the digital output signals from the metering calculator and, possibly, from associated measuring instruments, which processes them into data for the indicating device.

Note : The metering calculator and the operational calculator may be two separate elements or form a single unit. Except where there is a particular need to dissociate the two kinds of calculators the association of both functions is called the calculator in this Recommendation.

3.1.5 (T.1.4) indicating device

part of the meter which displays continuously the measurement results.

Note: A printing device which provides an indication at the end of the measurement is not an indicating device.

3.1.6 (T.1.5) ancillary device

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

Note:

Main ancillary devices are :

a) zero setting device,
b) repeating indicating device,
c) printing device,
d) memory device,
e) price indicating device,
f) totalizing indicating device,
g) pre-setting device,
h) self-service device.

3.1.7 (T.1.6) additional device

part or a device, other than an ancillary device, required to ensure correct measurement or intended to facilitate the measuring operations, or which could in any way affect the measurement.

Note:

Main additional devices are :

a) filter,
b) device used for the transfer point,
c) anti-swirl device,
d) branches or bypasses,
e) valves, hoses, and in general, all the gaseous piping.

3.1.8 (T.1.8) compressed gaseous fuel measuring systems for vehicles

measuring system intended for the refueling of motor vehicles with compressed gaseous fuel.

Note: Hereafter such a system is referred to as "measuring system".

3.1.9 (T.1.9) pre-setting device

device which permits the selection of the quantity value to be measured and which automatically stops the flow of the gas at the end of the measurement of the selected quantity.

Note : The pre-set quantity value may be the mass or the related price to pay.

3.1.10 (T.1.10) adjustment device

device incorporated in the meter, that only allows shifting of the error curve generally parallel to itself, with a view to bringing errors within the maximum permissible errors.

3.1.11 (T.1.11) associated measuring instrument

instrument connected to the calculator or the correction device, for measuring certain quantity values which are characteristic of the gas, with a view to making a correction.

3.1.12 (T.1.12) correction device

device connected to or incorporated in the meter for automatically correcting the mass, by taking into account the flow rate and/or the characteristics of the gas to be measured (viscosity, temperature, pressure...) and the pre-established calibration curves.

3.1.13 (T.1.13) transfer point

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point (physical location) in the measuring system downstream the meter after which the gas is defined being delivered.

3.1.14 (T.5.4) checking facility *(as in draft OIML D 11, 3.19)*

facility that is incorporated in a measuring instrument or system to detect and act upon:

a) events that otherwise will result in significant faults and/or

b) incorrect functioning of a specific device of the measuring instrument or system and/or

c) disturbed communication between specific devices of the measuring instrument or system .

Note: «Acted upon» refers to any adequate response by the measuring instrument (luminous signal, acoustic signal, prevention of the measurement process, etc.).

3.1.15 automatic checking facility*(as in draft OIML D 11, 3.19.1)*

checking facility that operates without the intervention of an operator.

3.1.15.1permanent automatic checking facility (type P) *(as in draft OIML D 11, 3.19.1.1)*

automatic checking facility that operates at each measurement cycle.

3.1.15.2intermittent automatic checking facility (type I) *(as in draft OIML D 11, 3.19.2)*

automatic checking facility that operates at certain time intervals or per fixed number of measurement cycles.

3.1.16 non-automatic checking facility (type N) *(as in draft OIML D 11, 3.19.3)*

checking facility that requires the intervention of an operator

3.1.17 Low capacity dispenser

3.2 (T.2) self-service measuring systems

3.2.1 (T.2.1 reedited) self-service arrangement

arrangement that allows the purchaser of the gas to personally utilize a measuring system for the purpose of obtaining gas.

3.2.2 (T.2.2) self-service device

specific device that is part of a self-service arrangement and which allows one or more measuring systems to perform in this self-service arrangement.

Notes : The self-service device includes all the elements and constituents that are mandatory so that a measuring system performs in a self-service arrangement.

The arrangement is made of a self-service device and connected measuring systems.

3.2.3 (T.2.3) attended service mode

operating mode of a self-service arrangement in which the supplier is present and controls the authorization for the delivery.

Notes :

1) In attended service mode, the settlement of the transaction takes place before the customer leaves the site of the delivery.

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2) A transaction is settled when the parties interested in the transaction have made their agreement known (explicitly or implicitly) as regards the amount of the transaction. This may be a payment, signing a credit card voucher, signing a delivery order, etc.

3) The parties interested in a transaction may be the parties themselves or their representatives (for example: the employee in a filling station, the driver of a truck).

4) In attended service mode the measurement operation ends at the moment settlement of the transaction takes place.

3.2.4 (T.2.4) unattended service mode

operating mode of a self-service arrangement in which the self-service arrangement controls the authorization for the delivery, based on an action of the customer.

Note : In unattended service mode, the end of the measurement operation is the end of the registration (printing and/or memorizing) of information concerning the measurement operation.

3.2.5 (T.2.5) pre-payment

type of payment in attended or unattended service mode requiring payment for a quantity of gas before the delivery commences.

3.2.6 (T.2.6) attended post-payment (or post-payment)

type of payment in attended service mode requiring payment for the delivered quantity after the delivery but before the customer leaves the site of the delivery.

3.2.7 (T.2.7) unattended post-payment (or delayed payment)

type of payment in unattended service mode in which payment for the delivered quantity is required after the delivery, but in which the transaction is not settled when the customer leaves the site, following an implicit agreement with the supplier.

3.2.8 (T.2.8) authorization of a measuring system

operation that brings the measuring system into a condition suitable for the commencement of the delivery.

3.3 (T.3) metrological characteristics

3.3.1 (T.3.1) primary indication

indication (displayed, printed or memorized) which is subject to legal metrology control.

Note: Indications other than primary indications are commonly referred to as secondary indications.

3.3.2 (T.3.5) minimum measured quantity of a measuring system

minimum delivery

minimum totalized mass in one batch of gas required to fulfill the metrological criteria of the specific measuring system

Note: Measuring systems should not be used for measuring quantities less than the MMQ

3.3.3 (T.3.6) minimum specified mass deviation

absolute value of the maximum permissible error for the minimum measured quantity of a measuring system.

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3.3.4 (T.3.8) repeatability error

difference between the largest and the smallest results of the several successive measurements of the same quantity carried out under the same *repeatability condition*[1].

3.3.5 (T.3.9) intrinsic error

error of a measuring system determined under reference conditions.

3.3.6 (3.1.1) significant fault *(adopted from OIML D 11, 3.10)*

fault exceeding the applicable fault limit value (specified in 5.6.)

3.4 (T.4) tests and test conditions

3.4.1 (T.4.6) performance test

test intended to verify whether the measuring system under test (EUT) is capable of accomplishing its intended functions.

3.4.2 (T.4.8) bank

test reservoir or a set of test reservoirs connected together, which forms part of a multi-segment gas storage system and for which the segments operate at different pressure levels from one another in refueling systems fitted with or using a sequential control device (see T.4.9 below).

Note: Testing using banks generate transient flow rates.

3.4.3 (T.4.9) sequential control device

device which allows switching from a bank to another one. This device may be included in a measuring system or may be part of the refueling station.

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[1] VIM (2010) 2.20

3.5 (New) Abbreviations and symbols used

AC Alternating Current
AM Amplitude Modulation
ASD Acceleration Spectral Density
CF Change in flow rate
CGF Compressed Gaseous Fuel
DC Direct Current
E_{min} Minimum specified mass deviation
EM Electro Magnetic
EMC Electro Magnetic Compatibility
e.m.f. electromotive force
ESD Electrostatic Discharge
EUT Equipment Under Test

IEC International Electrotechnical Committee
ISO International Organization for Standardization
MMQ Minimum Measured Quantity
MPE Maximum Permissible Error
OIML International Organization of Legal Metrology
P_{min} Minimum pressure of the gas
P_{max} Maximum pressure of the gas
P_{st} Maximum pressure of the gas in the refueling station gas storage
P_v Allowed maximum gas pressure during fast filling of the vehicle
Q_{min} Minimum flow rate
Q_{max} Maximum flow rate
RCF Relative Change in Flow rate
RMS Average (Root Mean Square)
T_{min} Minimum temperature of the gas
T_{max} Minimum temperature of the gas
V_d Test reservoir volume
V_{min} Minimum test receiver volume

4 Description of the measuring system and its constituents

4.1 Constituents of the measuring system

4.1.1 The measuring system shall include at least:

a) (2.1) meter;
b) (2.3.3) flow control system;
c) (5.2.1) emergency power supply;
d) (2.1 + 2.5.1) transfer point;
e) (2.1) the gas piping;
f) (4.3.1) zero setting device.

4.1.2 The measuring system may also be provided with the following other ancillary and additional (2.1) devices:

a) (T.1.3.1 + T.1.3.2) calculator;
b) associated measuring instruments;
c) (2.5.7) pressure gauge;
d) (4.2.1) digital indicating device;
e) (6) self service arrangement;
f) (4.7) presetting device;
g) (4.6.1) memory device;
h) (2.4.1 + 4.3.2) price indicating device;
i) (4.3.3) printing device;
j) (2.1) other ancillary and additional devices;.

4.2 Constituents of the meter

A meter itself is not a measuring system. **(2.1)**

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4.2.1 The meter shall include:

a) sensor
b) (T.1.1) measurement transducer;
c) (T.1.1 + T.1.4) indicating device;
d) Metering calculator

4.2.2 The meter may include:

a) (4.1.4) adjustment device;
b) (T.1.12 + 4.1.5) correction device;

4.2.3 A measuring system shall include only one meter. **(2.1)**

If several meters intended for separate measuring operations have common elements (calculator filter, etc.) each meter is considered to form, with the common elements, a measuring system. **(2.1)**

4.2.4 The typical configuration of measuring system (including the meter) is given in Figure 1 on the next page.

Note: The " devices" listed in 4.1 and 4.2 can be functions rather than physical devices. (See also 3.1.4).

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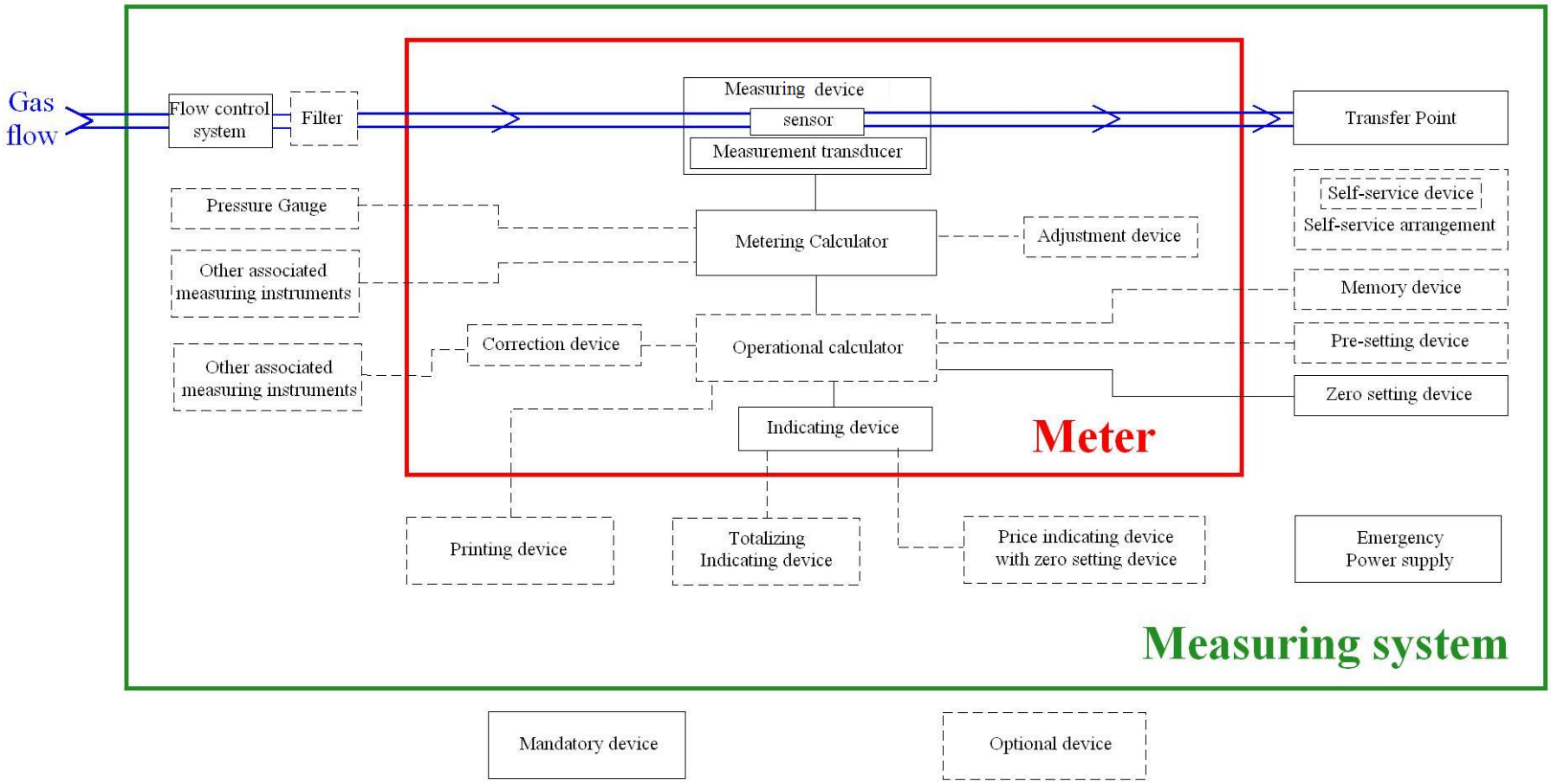

Figure 1 - Constituents of a typical compressed gaseous fuel measuring system for vehicles

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5 Metrological requirements for the measuring system

5.1 Presentation of the measuring result

The presentation of the measurement results should be unambiguous for all parties affected.

5.1.1 Units of measurement

The result of the measurement shall be displayed and/or printed in SI units of mass. **(2.4.2+4.5.1)**

If applicable, volume or other quantities shall be indicated in the applicable SI unit. **(2.4.2)**

If units of measurement different from the SI are required by national regulations of a specific country, these units of measurement shall be considered acceptable for indications in this specific country only. In international trade, the officially agreed equivalents between these units of measurement and those of the SI shall be applied

Any displayed or printed measuring result shall be clearly provided with the applicable unit symbol or name. **(2.4.2 + 4.5.1)**

5.1.2 Scale intervals **(2.4.6)**

The scale interval shall be in the form 1 x 10^n, 2 x 10^n or 5 x 10^n, where n is a positive or negative whole number, or zero.
The scale interval shall be equal to or smaller than half the minimum specified mass deviation (see note in 5.2.4 **(3.1.3)**).

Non-significant scale intervals should be avoided.

Note: This clause does not concern price indications.

5.1.3 Multiple indicating (or printing) devices **(2.4.3)**

A measuring system may have several devices indicating or printing the same measurement result. Each shall meet the requirements of this Recommendation if subject to control. The scale intervals of the various indications or prints shall be the same. For any measured quantity relating to the same measurement, there shall be no difference between the indications of multiple indicating or printing devices.

5.2 Maximum permissible error

5.2.1 **(3.1.1)** Without prejudice to 5.2.3 **(3.1.2)** and 5.2.4 **(3.1.3)**, the maximum permissible errors on mass indications, positive or negative at type evaluation , initial verification and subsequent verification, are equal to:

* for the meter :
  - 1 % of the measured quantity;

* for the complete measuring system:
  - 1.5 % of the measured quantity.

5.2.2 **(3.2.1)** The maximum permissible errors apply for all gases to be metered, all possible ambient conditions of temperatures and pressures, and all flow rates for which the system or the meter is intended to be used.

A measuring system or a meter shall be capable of fulfilling all requirements without adjustment or modification during the relevant evaluation procedure.

5.2.3 **(3.1.2)** The maximum permissible error on mass indications, positive or negative, in service performed under rated operating conditions, is equal to 2 % of the measured quantity for the complete measuring system.
*Note: "*In service" refers to any period of time between verifications. National authorities may decide to apply a different maximum permissible error.

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5.2.4 **(3.1.3)** The maximum permissible error applicable to the minimum measured quantity is twice the corresponding value as stated in 5.2.1 **(3.1.1)**.

The minimum specified mass deviation (E_{min}) is presented by the following formula:

$$E_{min} = 2 \cdot MMQ \cdot R_{MPE} \ [g; kg]$$

where: R_{MPE} = the maximum permissible error ratio according to 5.2.1 resp. 5.2.3

MMQ = the specified minimum measured quantity according to 5.3.2 **(2.3.2)**.

when inserting the statements of 5.2.1. results in:

$E_{min} = 0{,}02\ MMQ\ [g; kg]$ for a meter,

$E_{min} = 0{,}03\ MMQ\ [g; kg]$ for the measuring system, and

when inserting the statement of 5.2.3. results in:

$E_{min} = 0{,}04\ MMQ\ [g; kg]$ for the complete system in service

Note: The minimum specified mass deviation is an absolute maximum permissible error.

5.2.5 **(3.1.4)** Whatever the measured quantity may be, the magnitude of the maximum permissible error (expressed in units of mass) for the complete system is never less than the minimum specified mass deviation.

5.3 Measuring range

5.3.1 Flow rate

(2.3.1, 2.3.3) The flow measuring range is limited by the minimum flow rate Q_{min} and the maximum flow rate Q_{max} and shall be specified by the manufacturer of the system. This measuring range shall satisfy the conditions of use of the measuring system; the latter shall be designed so that the flow rate stays between the minimum flow rate and the maximum flow rate, except at the beginning and at the end of the measurement or during interruptions.

In normal conditions of use, a flow control system shall prevent the delivery of flow rates less than the minimum flow rate of the measuring system.

The measuring range of a measuring system shall be within the measuring range of each of its elements.

The ratio between the maximum flow rate and the minimum flow rate shall be at least 10.

~~A flow beneath the minimum flow rate during the course of a complete delivery is allowed only for a maximum period of 2 seconds. The flow shall automatically be terminated in case this period of time is exceeded.~~

5.3.2 Minimum measured quantity

(2.3.1, 2.3.2) The minimum measured quantity shall be specified by the manufacturer of the measuring system. It shall have the form 1 x 10^n, 2 x 10^n or 5 x 10^n kg, where n is a positive or negative whole number, or zero and it shall satisfy the conditions of use of the measuring system. .

The maximum value of the minimum measured quantity *MMQ* depends on the maximum flow rate in accordance with Table 1.

Table 1 maximum value of the minimum measured quantity *MMQ*						
	$Q_{max} \leq 4$	$4 < Q_{max} \leq 12$	$12 < Q_{max} \leq 30$	$30 < Q_{max} \leq 70$	$Q_{max} > 70$	*kg/min*
MMQ ≤	*0.5*	*1*	2	5	10	*kg*

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5.4 Repeatability

(3.1.6 amended)

For any quantity of the measurand equal to or greater than 1000 scale intervals of the meter,

- the repeatability error of the meter shall not exceed 0,6 %
- the repeatability error of the measuring system shall not exceed 1%.

(3.1.7 amended) This requirement concerning repeatability shall be met durably, which shall be demonstrated during the type evaluation.

5.5 Specifications of ambient and rated operating conditions

5.5.1 Ambient conditions

The manufacturer may specify ambient conditions for a meter or system, based on the intended use of the instrument or devices taking into account table 2 (Rated operating conditions). The identification plate and the operating instructions shall indicate the corresponding limits of use. (see clauses 7 and 8)

5.5.2 Rated operating conditions (5.1.1, A.4 amended)

Meters and measuring systems according to this Recommendation shall be designed and manufactured such that their metrological functions are safeguarded and their errors do not exceed the maximum permissible errors under the following rated operating conditions:

Table 2 Rated operating conditions

a)	High ambient temperature [1] **(4.1.1) (t_{ah})**	+ 30 °C, + 40 °C, +55 °C, +70 °C or + 85 °C [2]	Temperature range at least 40 °C
b)	Low ambient temperature [1] **(4.1.1) (t_{al})**	+ 5 °C, -10 °C, -25 °C, or -40 °C [2]	
c)	Temperature of the gas	As specified by the manufacturer	
d)	Pressure of the gas	As specified by the manufacturer	
e)	Relative humidity	As specified by the manufacturer [4]	
f)	Vibration (random) **(A.4.4)**	As specified by the manufacturer not to exceed 10 Hz - 150 Hz, 1.6 $m.s^{-2}$, 0.05 $m^2.s^{-3}$, -3 dB/octave unless the manufacturer specifies higher insusceptibility levels[5]	
g)	DC mains voltage/ Voltage of internal battery [3] **(A.4.9; A.4.10)**	As specified by the manufacturer	
h)	Voltage of road vehicle battery	As specified by the manufacturer (12 ± 4)V and/or (24 ± 8)V [6]	
i)	AC mains voltage [3] **(A.4.10)**	U_{nom} - 15 % to U_{nom} + 10 %	

[1] These temperatures refer only to the ambient temperature. The temperature of the gas may be different but the range shall cover at least + 10 °C to + 40 °C.

[2] These values are to be decided by national legislation, as it depends on the climatic conditions and the expected conditions of application (indoors, outdoors, etc.) that are different in different countries.

[3] Whatever is applicable

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(4) A choice may be made between:

- those instruments or parts of instruments typically to be used in closed (weather protected) locations where the local climate is not controlled
- those instruments or parts of instruments to be used in open air locations.

(5) At least for mobile dispensers the environmental random vibration is considered more intense than delimited by the presented range.

(6) In conformity with ISO 16750-2

5.6 Significant fault (T.3.12)

5.6.1 Concerning the mass being measured a significant fault is a fault the magnitude of which exceeds the larger of these two values :

a) one tenth of the magnitude of the maximum permissible error at type evaluation for the measuring system for the mass measured;
b) the minimum specified mass deviation.

5.6.2 Concerning the amount (of money) to pay, a significant fault is a fault in the displayed or printed amount corresponding the significant fault for the mass.

Note: No fault is allowed in the unit price.

5.6.3 The following faults are not considered being significant faults:

a) faults arising from simultaneous and mutually independent causes in the measuring instrument itself or in its checking facilities;
b) transitory faults being momentary variations in the indication, which cannot be interpreted, memorized or transmitted as a measurement result;
c) faults implying the impossibility of performing any measurement.

5.7 Disturbances (5.1.2)

Measuring systems within the scope of this Recommendation shall be designed and manufactured such that, when becoming exposed to the disturbances as specified in table 3 and table 3a (in case applicable) and table 4

a) either significant faults do not occur, or
b) significant faults are detected and acted upon by means of checking facilities,

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

- each individual cause of significant fault; and/or
- each part of the measuring system.

The choice of whether a) or b) is applied, is left to the manufacturer,

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5.7.1 Table 3 Disturbances to which the measuring system is expected to be exposed during full operation

a)	RF electromagnetic fields	up to 3 GHz, up to 10 V/m
b)	Common mode currents induced by RF electromagnetic fields	up to 80 MHz, up to 3 V (e.m.f.)
c)	Bursts (transients) on AC and DC mains lines	Amplitude 1 kV, Repetition rate 5 kHz
d)	Bursts (transients) on signal, data and control lines	Amplitude 0,5 kV, Repetition rate 5 kHz
e)	AC mains voltage dips	0,5 cycles to 0 % 1 cycle to 0 % 10/12 cycles to 40% 25/30 (1) cycles to 70 % 250/300 cycles to 80%
~~f)~~	~~AC mains short interruptions~~	~~250/300 (1) cycles 0 %~~
g)	Voltage dips, short interruptions and voltage variations on DC mains power	40 % and 70 % of the rated voltage during 0,1 s 0 % of the rated voltage during 0.01 s 85 % and 120 % of the rated voltage during 10 s
h)	Ripple on DC input power	2 % of the nominal DC voltage
(1)	For 50 Hz/ 60 Hz respectively	

5.7.2 Table 3a Additional disturbances to which the measuring system is expected to be exposed during full operation when installed in industrial environment

a)	Common mode currents induced by RF electromagnetic fields	up to 80 MHz, up to10 V (e.m.f.)
b)	Bursts (transients) on AC and DC mains lines	Amplitude 2 kV, Repetition rate 5 kHz
c)	Bursts (transients) on signal, data and control lines	Amplitude 1 kV, Repetition rate 5 kHz

5.7.3 Table 4 Disturbances to which being exposed before being in full operation:

a)	Damp heat, cyclic (condensing)	at t_{ah} °C, R.H. > 93 %
b)	Electrostatic discharge	Contact discharge:6 kV Air discharge: 8 kV
c)	Surges line to line on mains power and unbalanced signal data and control lines	1 kV
d)	Surges line to earth on mains power and signal data and control lines	2 kV

Note: ***(New)*** *A fault equal to or smaller than the significant fault according to 5.6.1 is allowed irrespective of the value of the error of indication.*

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5.8 Durability

5.8.1 **(5.1.3)** The requirements in 5.5.2 **(5.1.1)** and 5.7 **(5.1.2)** shall be met durably.

For this purpose the measuring systems shall be provided with checking facilities as specified in 6.10 **(5.3)**.

5.8.2 **(3.1.7)** Following a period of operation in which the meter in normal use registers (indicates) a total mass equivalent to at least 100 hours of operation at 0,8 Q_{max} the meter shall not show a significant durability error..

For the purpose of this Recommendation a significant durability error is a durability error the magnitude of which equals or exceeds ±1% of the measured quantity.

6 Technical requirements for the measuring system

6.1 Construction

(New) The measuring system and, if applicable, its modules shall be designed to suit its intended purpose. And they shall be solidly and carefully constructed in order to ensure that it maintains its metrological qualities during a reasonable period of use.

Measuring systems may consist of more than one bank of vessels differing in maximum compression level.

A measuring system shall be constructed in such a way that possibilities for unintentional, accidental, or intentional misuse are minimal.

Note:

Specifications for hydrogen application may be significantly different from those for CNG.

6.2 Presentation of measured value

In addition to the requirements in 5.1, the following requirements apply:

6.2.1 Indicating device

(2.4.1 + 4.2.1) The meter shall be equipped with a digital indicating device displaying the mass of gas measured.

(2.4.1) National authorities may allow the mass indication to be complemented with a secondary (informative) indication of volume, energy or other quantity, provided the status of this informative indication is clear and unambiguous and is not misleading with respect to the actual amount. Moreover in this case, the conversion factor used for converting from mass to the secondary indication shall be displayed on the front face of the measuring system. Only rounding errors are permitted on conversion.

If the system is fitted with a price indicating device, the national authority should impose that:

a) indications of unit price and price to be paid are related only to mass;

b) these indications are displayed only when displaying the mass.

6.2.1.1 Size of the figures (4.2.3)

The height for the figures of the digital display device shall be equal to or greater than 10 mm.

6.2.1.2 Grouping of numbers and decimal sign (4.5.1)

Displayed or printed numbers may be divided in groups of three in order to facilitate reading; neither dots nor commas shall be inserted in the space between groups.

If the magnitude of the number is less than unity, the decimal sign should be preceded by a zero.

The decimal marker displayed or printed by the measuring instrument shall be either a comma on the line or a dot on the line. Use of the comma and/or the dot is left to national habit or legislation.

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Notes: (1) In accordance with OIML policy, the dot is used in the English version of this Recommendation and a comma in the French version.

(2) ISO 31-0 (1992), clause 3.3.2, says: "The decimal sign is a comma on the line. If the magnitude of the number is less than unity, the decimal sign should be preceded by a zero", with a note: "Note 17 In documents in the English language, a dot is often used instead of a comma. If the dot is used, it should be on the line. In accordance with an ISO Council decision, the decimal sign is a comma in ISO documents."

6.2.1.3 **(New)** Reading of the results (on display as well as in print) shall be reliable, easy and unambiguous under conditions of normal use.

In addition to the requirements in 5.1, the figures forming the results shall be of a size, shape and clarity for reading to be easy.

The scales, numbering and printing shall permit the figures which form the results to be read by simple juxtaposition.

6.2.2 **(2.4.5)** The common use of one and the same indicating device for indicating the measurement results of several measuring systems is authorized provided that it is impossible to use these measuring systems simultaneously and that the measuring system providing the actual indication is clearly identified. Where in such common use the indicating device is applied for different fluids (for example for compressed gasses as well as liquid fuels) the same provision applies provided that only the applicable unit of measurement, related to the indicated quantity value, is unchallengeable and clearly indicated (e.g. kg for mass, liter or cubic meter for volume).

6.2.3 **(2.4.7)** When relevant, the provisions relating to mass indications apply also to price indications by analogy and, to secondary indications of other quantities as well.

6.2.4 **(4.2.2)** The continuous display of mass during the period of measurement is mandatory.

6.2.5 **(New)** A digital indication or print shall display at least one figure beginning at the extreme right.

A decimal fraction shall be separated from its integer by a decimal sign (see 5.1.2), with the indication showing at least one figure to the left of the sign and all figures to the right.

Zero may be indicated by one zero to the extreme right, without a decimal sign.

6.2.6 **(New)** If the instruments are connected to an external printing device or data storage, the data transmission from the instruments to the printing device shall be designed so that the results cannot be falsified.

It shall not be possible to print a document or store the measuring data in an external device for legal purposes if the instrument checking facility(ies) detect(s) a significant fault or a malfunction.

6.2.7 **(4.4) Price indicating device**

6.2.7.1 **(4.4.1)** A mass indicating device may be complemented with a price indicating device which displays both the unit price and the price to be paid.

The monetary unit or its symbol shall appear in the immediate vicinity of the indication.

6.2.7.2 **(4.4.2)** The selected unit price shall be displayed by an indicating device before the start of the measurement. The unit price shall be adjustable; changing the unit price may be carried out either directly on the measuring system or through peripheral equipment.

The indicated unit price at the start of a measurement operation shall be valid for the whole transaction. A new unit price shall only be effective at the moment a new measurement operation may start.

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A time of at least 5 s shall elapse between indicating a new unit price and before the next measurement operation can start, if the unit price is set from peripheral equipment.

6.2.7.3 **(4.4.3)** Only rounded errors pertaining to the least significant digit of the price to be paid are authorized.

6.2.8 (4.5) Printing device

6.2.8.1 **(4.3.3)** If the measuring system is fitted with a printing device, any printing operation of measurement data of the current transaction shall not be possible during the course of a measurement. The printing operation itself shall not initiate any change in the quantity indicated on the indicating device.

6.2.8.2 **(4.5.2)** The printing device may print information identifying the measurement such as: sequence number, date, identification of the measuring system, type of gas, license plate , etc.

If the printing device is connected to more than one measuring system, it shall print the identification of the relevant system.

6.2.8.3 **(4.5.3)** If a printing device allows repetition of the printing before a new delivery has started, copies shall be clearly marked as such, for example by printing "duplicate".

6.2.8.4 **(4.5.4)** The printing device may print, in addition to the measured quantity, either the corresponding price or this price and the unit price.

6.2.8.5 **(4.5.5)** The printing devices are also subject to the requirements in 6.10.5 **(5.3.5)** *(Checking facilities for ancillary devices)*.

6.2.8.6 **(New)** In addition to the requirements in 5.1, the following requirements apply to a printer:

a) printing shall be clear and permanent for the intended use. If relevant, the manufacturer shall specify the type of paper to be used in order to fulfill this requirement.
It shall be ensured that the print does not fade and shall be readable for a period of at least a trimester.

b) printed numeric characters shall be at least 2 mm in height;

c) on the print-out / hard copy, the name or the symbol of the unit of measurement shall be either to the right of the value or above a column of values.

d) In case the printer fails (for instance being switched off, out of paper or ink, or in case of disturbed communication), a warning shall be given or the measurement shall be prohibited;

e) in case of an external printing device, the data transmission shall comply with 6.4.

6.3 Storage of measurement results (Memory device; hardware) (4.6)

(New) The measuring results shall be recorded using sustainable means and shall include all information needed for identifying the particular measurement. This may be provided by means of a print and/or by storage in a non volatile memory.

6.3.1 **(4.6.1)** Measuring systems may be fitted with a memory device to store measurement results until their use or to keep a trace of commercial transactions, providing proof in case of a dispute. Devices used to read stored information are considered as included in the memory devices.
(New:) It shall be assured that means are available for future recovery of the stored data.

These means shall be readily available during the whole life-cycle of the measuring system at:

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- the measuring system location, or
- any other appropriate location (for instance in the central office of the company that owns the measuring system).

6.3.2 **(4.6.2)** The medium on which data are stored must have sufficient permanency to ensure that the data will not become corrupted under normal storage conditions.

Note: For roadside measuring systems storage for three months corresponding to normal use is advisable.

6.3.3 **(4.6.4)** Storage shall be such that it is impossible in normal use to modify stored values (see also Annex A (A.2.3.2).

6.3.4 **(4.6.5)** Memory devices shall be fitted with checking facilities according to 6.10.5 **(5.3.5)**. The aim of the checking facility is to ensure that stored data correspond to the data provided by the calculator and that restored data correspond to stored data.
It shall not be possible to store the measuring data in an external device if the instrument checking facility(ies) detect(s) a significant fault or a malfunction.

6.4 Data transmission (New)

The instrument may be equipped with an interface permitting coupling to any peripheral devices or other instruments.

An interface shall not allow the metrological functions of the instruments or their measurement data to be inadmissibly influenced by the peripheral devices, by other interconnected instruments, or by disturbances acting on the interface.

Functions that are performed or initiated via an interface shall meet the relevant requirements and conditions of clause 6.11

If the instrument is connected to a data printer or an external data storage device, the design of the data transmission shall ensure that the measuring results cannot be falsified.

6.5 Zero-setting device (4.3)

6.5.1 **(4.3.1)** Measuring systems shall be equipped with a zero setting device for resetting the mass indicating device to zero.

6.5.1.1 **(4.3.1.1)** The zero setting device shall only permit the measurement result shown by the indicating device to be reset to zero.

6.5.1.2 After finishing a previous delivery any further delivery shall only be possible after a reset to the zero value indication.

6.5.1.3 **(4.3.1.2)** Once the zeroing operation has begun, it shall be impossible for the mass indicating device to show a result different from that of the measurement which has just been made, until the zeroing operation has been completed.

The measuring system shall not be capable of being reset to zero during measurement.

6.5.2 **(4.3.2)** If the system also includes a price indicating device, this indicating device shall be fitted with a zero setting device.

The zero setting devices of the price indicating device and of the mass indicating device shall be designed in such a way that zeroing either indicating device automatically involves zeroing the other.

6.5.3 **(4.3.4)** If the measuring system is designed so that registration of mass could occur without any effective flow rate, a device shall register this apparent flow rate and compensate the measurement result for it.

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6.6 Pre-setting device (4.7)

Measuring systems may be provided with a pre-setting device.

6.6.1 **(4.7.1)** The selected quantity is pre-set by operating a digital device which indicates that quantity. The preset quantity shall be indicated before the start of the measurement.

6.6.2 **(4.7.2)** Where it is possible to simultaneously view the figures of the display device of the pre-setting device and those of the mass indicating device, the former shall be clearly distinguishable from the latter.

6.6.3 **(4.7.3)** Indication of the selected quantity may, during measurement, either remain unaltered or return progressively to zero. However, it is acceptable to indicate the preset value on the indicating device for mass by means of a special operation with the restriction that this value shall be replaced by the zero indication for mass before the measurement operation can start.

6.6.4 **(4.7.4)** The difference found under normal operating conditions, between the pre-set quantity and the quantity shown by the mass indicating device at the end of the measurement operation, shall not exceed the minimum specified mass deviation. **[Test to be added to 18 or to take into account in 17.1.1]]**

6.6.5 **(4.7.5)** The pre-set quantities shall be expressed in units of mass according to 5.1.1. This unit or its legal symbol shall be marked on the pre-setting device.

6.6.6 **(4.7.6)** The scale interval of the pre-setting device shall be equal to the scale interval of the indicating device.

6.6.7 **(4.7.7)** Pre-setting devices may incorporate a device to permit the flow of gas to be stopped quickly when necessary.

6.6.8 **(4.7.8)** Measuring systems with a price indicating device may also be fitted with a price pre-setting device which stops the flow of the gas when the quantity delivered corresponds to the pre-set price. The requirements in 6.6.1 to 6.6.7 **(4.7.1 to 4.7.7)** apply by analogy.

6.7 Calculator (4.8)

6.7.1 **(4.8.1)** The maximum permissible errors, positive or negative, on the gas quantity indications applicable for the calculators when they are checked separately are equal to 0.05 % of the true value. They apply to the metering calculator and to the operational calculator, where applicable.
[Test to be added to 18 or to take into account in 17.1.1]

6.7.2 **(4.8.2)** All parameters necessary for the elaboration of indications that are subject to legal metrology control, such as unit price, calculation table, correction polynomial, etc. shall be present in the calculator at the beginning of the measurement operation.

6.7.3 **(4.8.3)** The calculator may be provided with interfaces permitting the coupling of peripheral equipment. When these interfaces are used, the instrument shall continue to function correctly and its metrological functions shall not be capable of being affected.

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6.8 Emergency power supply device (5.2)

6.8.1 **(5.2.1)** A measuring system shall be provided with an emergency power supply device allowing either:

a) all measuring functions to be safeguarded during a failure of the principal power supply, or

b) that data contained at the moment of a failure leading to stopping the flow are saved and displayable on an indicating device subject to legal metrology control for sufficient time to permit the conclusion of the current transaction.

The absolute value of the maximum permissible error for the indicated mass, in the second case, is increased by 5 % of the minimum measured quantity.

6.8.2 **(5.2.2)** In case of a failure leading to stopping the flow, measuring systems shall be such that the minimum duration of operation of the display shall be either:

a) continuously and automatically for at least 15 minutes immediately following the failure of the principal electrical supply, or

b) a total of at least 5 minutes in one or several periods controlled manually during one hour immediately following the failure.

In addition, measuring systems shall be designed so that an interrupted delivery cannot be continued after the power supply device has been re-established if the power failure has lasted more than 15 s.

6.9 Protection against fraud (new)

A measuring system, including its ancillary devices installed according to the manufacturer's instructions, shall have no characteristics likely to facilitate its fraudulent use; neither by accidental nor by deliberate means when using the instrument in the normal manner; whereas possibilities for unintentional misuse shall be minimal. The general essential requirement dealing with fraudulent use shall be fulfilled in such a way that the interests of all parties involved in the transaction are protected.

As far as applicable, the following aspects shall be taken into account:

6.9.1 Except for a reset of the indication to zero and setting the unit price, it shall be impossible to make any metrological relevant adjustments without breaking the seals (see 9).

6.9.2 The possibility to change software shall comply with the requirements in 6.11.

6.9.3 The risk of calculated (deliberate) influence by digital telephones, static magnets, etc. shall be minimized. (For disturbances by radiated, radio frequency electromagnetic fields see also 5.7.1, a).

6.9.4 Data transmission shall comply with 6.4.

6.10 Checking facilities (5.3)

6.10.1 (5.3.1 modified) Action of checking facilities

The detection by the checking facilities of significant faults and/or of incorrectness in the generation, transmission, processing and/or indication of measurement data shall result in an action.
The action of checking facilities depends on the type of facility.

6.10.1.1 The following action is applicable upon a malfunction detection by checking facilities of type N:

- a visible or audible alarm for the attention of the operator.

6.10.1.2 The following action is applicable upon a malfunction detection by checking facilities of type I or P:

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- automatic correction of the malfunction; or
- stopping only the faulty device, when the measuring system without that device continues to comply with the regulations; or
- stopping the flow

6.10.2 (5.3.2) Checking facilities for the measurement transducer

Checking facilities shall be implemented which are able to verify the presence of the transducer, its correct operation and the correctness of data transmission.

These checking facilities shall be of type P and the checking shall occur at time intervals not exceeding the duration of the measurement of an amount of gas equal to the minimum specified mass deviation.

The design of the measuring system and the meter shall be such that it is possible to check during type evaluation that these checking facilities function correctly:

a) by disconnecting the transducer, or
b) by interrupting one of the sensor's pulse generators, or
c) by interrupting the electrical supply of the transducer.

This checking shall be also possible at initial verification unless the presence and the efficiency of the checking facility is ensured by the conformity to type.

All dispensers with electronic indicators shall be fitted with a time-out device that terminates a transaction (i.e. the dispenser is reset to zero before delivery starts), should a period of inactivity (no flow) of more than 120 seconds occur during the transaction.

6.10.3 (5.3.3 modified) Checking facilities for the calculator

These checking facilities shall verify that the calculator system functions correctly and to ensure the validity of the calculations made.

There are no special means required for indicating that these checking facilities function correctly.

6.10.3.1 (5.3.3.1) The checking of the functioning of the calculation system shall be of types P or I. In the latter case, the checking shall occur at least every five minutes in the course of a delivery but at least once during a delivery.

The objective of the checking is to verify that:

a) The values of all permanently memorized instructions and data are correct, by such means as:
   1) summing up all instruction and data codes and comparing the sum with a fixed value,
   2) line and column parity bits (LRC and VRC),
   3) cyclic redundancy check (CRC 16),
   4) double independent storage of data,
   5) storage of data in "safe coding", for example protected by checksum, line and column parity bits,
b) All procedures of internal transfer and storage of data relevant to the measurement result are performed correctly, by such means as:
   1) write-read routine,
   2) conversion and reconversion of codes,
   3) use of "safe coding" (checksum, parity bit),
   4) double storage.

6.10.3.2 (5.3.3.2) The checking of the validity of calculations shall be of type P. This consists of checking the correct value of all data related to the measurement whenever these data are internally stored or transmitted to peripheral equipment through an interface; this check may be carried out by such means as parity bit, checksum or double storage. In addition, the calculation system shall be provided with a means of controlling the continuity of the calculation program.

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6.10.4 (5.3.4) Checking facility for the indicating device

This checking facility shall verify that the primary indications are displayed and that they correspond to the data provided by the calculator. In addition the checking facility shall verifyi the presence of the indicating devices, if they are removable. These verifications may be performed in one of two possible ways: either according to the first possibility which is presented in 6.10.4.2 **(5.3.4.2)**. or the second possibility in which is presented in 6.10.4.3 **(5.3.4.3)**.

6.10.4.1 **(5.3.4.1)** It shall be possible to determine the presence and correct operation of the checking facility during type evaluation and verification either :

a) by the disconnection of all or part of the indicating device, or

b) by an action which simulates a failure in the display, such as using a test button.

6.10.4.2 **(5.3.4.2)** The first possibility is to automatically control the complete indicating device. The checking facility of the indicating device is of type P. However, it may be of type I if a primary indication is provided by another device of the measuring system or, if the indication may be easily determined, from other primary indications (for example, in the case of the presence of a price indicating device it is possible to determine the price to pay from the mass and the unit price).

Means may include, for example:

a) for indicating devices using incandescent filaments or LEDs, measuring the current in the filaments;

b) for indicating devices using fluorescent tubes, measuring the grid voltage;

c) for indicating devices using electromagnetic shutters, checking the impact of each shutter;

d) for indicating devices using multiplexed liquid crystals, output checking of the control voltage of segment lines and of common electrodes, so as to detect any disconnection or short circuit between control circuits.

6.10.4.3 **(5.3.4.3)** The second possibility is to automatically check the data transmitted to the indicating device and the electronic circuits used for the indicating device, except the driving circuits of the display itself, and to also check the display.

The automatic checking facility of the electronic circuits used for the indicating device is of type P; however, it may be of type I if a primary indication is provided by another device of the measuring system, or if the indication may be easily determined from other primary indications (for example, in the case of the presence of a price indicating device it is possible to determine the price to pay from the mass and the unit price).

The checking facility of the display shall provide visual checking of the entire display which shall meet the following description:

a) displaying all the elements ("eights" test if appropriate);

b) blanking all the elements ("blank" test);

c) displaying "zeros".

Each step of the sequence shall last at least 0.75 second.

This visual checking facility shall be of type I but it is not mandatory for a malfunction to result in the actions described in 6.10.1 **(5.3.1)**.

6.10.5 (5.3.5) Checking facilities for ancillary devices

An ancillary device (repeating device, printing device, self-service device, memory device, etc.) shall include a checking facility of type I or P. The object of this checking facility is to verify the presence of the ancillary device, when it is a necessary device, and to verify the correct transmission of data from the calculator to the ancillary device.

In particular, the checking of a printing device aims at ensuring that the printing controls correspond to the data transmitted by the calculator. At least the following shall be checked:

a. presence of paper;

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b. transmission of data and

c. the electronic control circuits (except the driving circuits of the printing mechanism itself).

It shall be possible during type evaluation to check that the checking facility of the printing device is functioning by an action that forces a printing malfunction. This action should be a simulated incorrectness in the generation, transmission (taking into account 6.10.2), processing, or indication of measurement data. Where the action of the checking facility is a warning, this shall be given on or by the ancillary device concerned or on another visible part of the measuring system.

6.10.6 (5.3.6) Checking facilities for the associated measuring instruments

Associated measuring instruments shall include a checking facility of type P. The aim of this checking facility is to ensure that the signal given by these associated instruments is within a pre-determined measuring range.

Examples:

a) four wire transmission for resistive sensors,

b) frequency filters for density meters,

c) control of the driving current for ~~4-20 mA~~ pressure sensors.

6.10.7 (New) Zero flow response

All dispenser systems ~~with electronic indicators~~ shall be fitted with a time-out device that terminates a single batch delivery should a period of inactivity (no flow) of more than 2 minutes occur during the transaction. (i.e. the meter will need to be reset to zero before a next batch delivery may start and 6.14.3 has been taken into account),

6.11 Software (New)

The requirements concerning the software applied in the measuring systems within the scope of this Recommendation are presented in the mandatory Annex A.

6.12 Technical requirements for measuring systems with self-service arrangement (6)

6.12.1 (6.1) General requirements

6.12.1.1 (6.1.1) Sealing and connection of the components are left to national regulations.

6.12.1.2 (6.1.2) Where the self-service device serves two or more measuring systems, each measuring system shall be provided with a measuring system identification number that shall accompany any primary indication provided by the self-service device.

6.12.1.3 (6.1.3) Indication of information that is not subject to metrological control is allowed, provided that it cannot be confused with metrological information.

6.12.1.4 (6.1.4) The control device of the self-service device should be capable of indicating the status of the measuring systems (e.g. running, authorized or unauthorized) that are connected to the self-service device and in the case of multiple modes of service and/or type of payment also that particular status of the measuring system.

6.12.1.5 (6.1.5) A change in the type of payment and/or mode of operation shall not be effective before the end of the current measurement operation.

6.12.1.6 (6.1.6) The self-service arrangement, including provisions related to clearly defined methods of operation, shall be such that at least one primary indication for the benefit of the customer must be

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available at least up to the settlement of the transaction to enable the delivered quantity and the price to pay to be checked.

(New) This indication for the customer shall be situated such, and be large enough to be easily readable for the customer during the filling process.

Note: This means that, for a specific installation, larger figures can be necessary than prescribed in 5.1.3.

6.12.1.7 **(6.1.7)** In the case of a self-service arrangement which totalizes the measured quantities for registered customers the minimum measured quantity is not applicable to the totalized quantities but applies for each measurement which is taken into account in the totalized quantity.

6.12.2 (6.2) Attended service mode

If the measuring system indicating device provides the only primary indication, provisions shall be made to inform the customer that the next authorization of a particular measuring system can only be given by the supplier after settlement of the current transaction.

6.12.2.1 (6.2.1) Attended post-payment

6.12.2.1.1 **(6.2.1.1)** Where the self-service arrangement includes a device that provides an additional primary indication to that of the indicating device of the measuring system, it shall consist of at least one installation for the reproduction of the mass and/or the price indicated by the measuring system indicating device, consisting of:

a) a printing device for the issue of a receipt to the customer, or

b) an indicating device for the benefit of the supplier together with a display for the benefit of the customer.

*Note: As a consequence of 6.2.9.4 **(4.5.4)**, the reproduction of the mass and price is necessary when the measuring system can be authorized before the settlement of the transaction.*

6.12.2.1.2 **(6.2.1.2)** For self-service devices with temporary storage (temporary storage mode) of measurement data of measuring systems the following requirements apply:

a) temporary storage of measurement data shall be organized so that the association of the data with the measurement is unambiguous for each measuring system when the results are recalled;

b) the necessary information shall be passed to the customer on the identification of his measurement in the sequence of storage of measurements;

c) when a primary indication of the self-service device is out of service, the self-service arrangement may continue its operation provided that it no longer uses any temporary storage, and that the measuring system indicating device remains the primary indication.

6.12.2.1.3 **(6.2.1.3)** Where the mandatory primary indication for the benefit of the customer is provided by a device in the form of a separate constructional unit and this unit becomes uncoupled, or if the checking facilities detect a malfunction, the temporary storage mode shall be prohibited and the measuring system indicating device remains the primary indication.

6.12.2.2 (6.2.2) Pre-payment in attended service mode

6.12.2.2.1 **(6.2.2.1)** The requirements of 6.6 **(4.7)** are applicable.

6.12.2.2.2 **(6.2.2.2)** A receipt of the prepaid amount is to be provided.

Note: If no print is provided a hand written receipt may be required. This however cannot be a requirement for the instrument. In general the national legislation will state which parameters need to be registered for a legal transaction; especially e.g. regarding the taxes to be paid.

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6.12.3 (6.3) Unattended service mode

6.12.3.1 (6.3.1) General

6.12.3.1.1 **(6.3.1.1)** The self-service arrangement shall provide additional primary indications by means of:

a) a printing device for the issue of a receipt to the customer, and

b) a printing or memory device on which measurement data are registered for the benefit of the supplier.

6.12.3.1.2 **(6.3.1.2)** When the printing devices or memory device, as required in 6.12.3.1.1 **(6.3.1.1)**, are not able to provide any indication or become unserviceable, the customer shall be clearly warned by automatic means before the operation commences.

Passing from attended to unattended service mode shall not be possible before correct operation of the arrangement is concluded as feasible by the checking facilities, including compliance with the above provision.

6.12.3.1.3 **(6.3.1.3)** Where the self-service arrangement is provided with individual volume totalizers, one for each registered customer and visible to the customer, the provisions of 6.12.3.1.1 **(6.3.1.1)** and 6.12.3.1.2 **(6.3.1.2)** do not apply to measurements related to such customers.

6.12.3.1.4 **(6.3.1.4)** Micro-processors, which upon disturbance or interference influence the measurement operation, shall be equipped with means for controlling the continuity of the processor program and for ensuring the discontinuation of the current delivery when the continuity of the processor program is no longer ensured.

The next effective acceptance of notes, cards or other equivalent mode of payment shall only take place if the continuity of the processor program is re-established.

6.12.3.1.5 **(6.3.1.5)** When a power supply failure occurs, the delivery data shall be memorized. The requirements of 6.8.2 **(5.2.2)** apply.

6.12.3.2 (6.3.2) Delayed-payment

The printed and/or memorized indications as mentioned in 6.12.3.1 **(6.3.1)** shall contain sufficient information for further checking, including at least the measured quantity, the price to pay and information to identify the particular transaction (e.g. the measuring system number, location, date, time).

6.12.3.3 (6.3.3) Pre-payment in unattended service mode

6.12.3.3.1 **(6.3.3.1)** Following the termination of each delivery, the printed and/or memorized indications as intended in 6.12.3.1 **(6.3.1)** shall be made available, clearly indicating the amount which has been prepaid and the price corresponding to the gas obtained.

These printed and/or memorized indications may be divided into two parts as follows:

a) one part provided prior to the delivery on which the pre-paid amount is shown and recognizable as such,

b) one part provided following the termination of delivery, provided that it is clear from the information provided on both parts that they are related to the same delivery.

6.12.3.3.2 **(6.3.3.2)** The requirements of 6.6 **(4.7)** are applicable.

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6.13 Battery-powered instruments (New)

In addition to 5.5.2, g), the following requirements apply for instruments powered by batteries:

Note: Non-rechargable batteries are not foreseen to serve as main power supply for an instrument and may only be applied as back-up battery according the provision 6.13.2

6.13.1 Rechargeable batteries

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

a. with the mains power switched off, comply with the following requirements:
   i. the instrument provided with new and/or fully charged batteries of the specified type shall comply with the metrological requirements;
   ii. as soon as the battery voltage has dropped below a level with the value specified by the manufacturer as the minimum voltage level at which the instrument complies with metrological requirements, this shall be detected and acted upon by the instrument;
   iii. the instrument shall initiate a warning to the operator at least 15 minutes before the battery voltage has dropped to the minimum voltage level as referred to in (ii).
b. with the mains power switched on, comply with the requirements for AC mains powered instruments

6.13.2 Back-up batteries *(D 11: 5.5.3)*

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

The provisions of 6.13.1, a) do not apply for back-up batteries.

6.14 Installation of the measuring system (2.2.4, 2.5.2)

6.14.1 **(2.2.4)** Additional devices likely to be installed in a measuring system shall not corrupt the metrological behavior of the measuring instrument.

6.14.2 **(2.5.2)** No means shall be provided by which any measured gas can be diverted downstream of the meter during a filling operation.

6.14.3 **(2.5.5)** The design of the system shall ensure that the measured quantity is delivered. In particular, if the hose downstream of the meter is likely to be depressurized between two deliveries this shall lead for instance to systematic correction or repressurizing before counting for the next delivery.

Whatever is the operating principle (repressurizing or not), in particular whatever constitutes the hose or the transfer point, in the worst measuring conditions, the mass which is measured but not delivered shall be smaller than or equal to half the minimum specified mass deviation if it is not corrected for.

Note: The purpose of this provision is not to allow a systematic deviation.

6.14.4 **(2.5.6)** If there is a risk that the supply conditions can provide a flow rate exceeding the Q_{max} of the measuring system, a flow limiting device shall be provided. It shall be possible to seal it.

6.14.5 **(2.5.7)** There shall be a provision for fitting and removing a pressure gauge on the measuring system in order to check P_{max}, and, if critical, P_{min}.

7 Markings (7.1)

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7.1 **(7.1.1)** Each measuring system, meter or other module for which type approval has been granted shall bear a permanent, non-transferable, and easily readable identification plate or label giving the following information:

a) (b) manufacturer's trade mark/corporate name;

b) (d) year of manufacture;

c) (c) type designation / model number;

d) (a) type approval number and (area allowed for) verification marks, according to national legislation;

e) (d) serial number of the measuring system and, if applicable, of each of the modules **(d)**;

The following metrological characteristic shall be permanently visible on the front of the indicating device:

- minimum measured quantity *MMQ*;

The following metrological and technical characteristic, where applicable, shall be provided either on the identification plate, or may be visible either permanently, or on demand on the indicating device, as appropriate:

a) (e) metrological characteristics:
   - measuring range (minimum flow rate, Q_{min}, and the maximum flow rate, Q_{max});
   - maximum pressure of the gas in the refueling station gas storage, P_{st};
   - maximum fast fill pressure of the gas-fuelled vehicle, P_v;
   - if critical, minimum pressure of the gas, P_{min};
   - maximum pressure of the gas, P_{max};
   - type(s) of the gas (mixtures) to be measured (e.g. natural gas, or hydrogen)
   - if applicable, information on density, composition, quality, etc. where related to the mass measurement characteristics;
   - maximum temperature of the gas, T_{max};
   - minimum temperature of the gas, T_{min}.
   - ambient temperature range.

b) (new) details of the electrical power:
   - in case of mains power: nominal mains voltage, frequency and power required;
   - in case of battery powered instruments and/ or internal removable back-up battery: the type (containing the information on the minimum capacity) and nominal voltage of the battery.

c) (new) identification of the software (see 6.11);

d) (f (modified)) presence and the operational mode of a sequential control device;

e) (g) where relevant, the maximum allowed speed of switching between banks for the sequential control device;

f) any required additional information as stated in the type approval certificate.

The markings required for each component may be combined on a single identification plate.

~~*Note: Instead of being presented on an identification plate, the above information of the measuring system except the minimum measured quantity, may alternatively be permanently visible or visualized on demand on the indicating device; the latter using a single key (sequential display); several keys or a combination of keys. Information on the sequence or combination of which shall be made permanently available.*~~

7.2 **(7.1.2 amended editorial)**

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The markings on the front of the indicating device of a meter shall not contravene those on the identification plate of the measuring system comprising this meter.

8 Instruction manual (New)

8.1 The instructions for operation of each individual measuring system shall be made available to the user[2] by means of a printed or printable instruction manual..

8.2 **(2.3.1 + new)** The text used in the instruction manual shall be in the official language(s) of the country (or an other generally accepted language according to national legislation) and easily understandable. Its contents shall at least include:

a) operating instructions;
b) rated operating conditions (see 5.5.2);
c) warm-up time after switching on the electrical power;
d) all other relevant mechanical and electromagnetic environmental conditions;
e) for instruments, powered by an external power converter or battery: specifications of this power converter or battery;
f) if applicable: details about compatibility with ancillary equipment;
g) any specific installation conditions like for instance a limitation of the length of signal, data, and control lines;
h) instructions for installation, maintenance, repairs, permissible adjustments (this can be in a separate document, not meant for the user/owner);
i) conditions for compatibility with interfaces, sub-assemblies (modules) or other measuring instruments;
j) minimum measured quantity *MMQ*;
k) minimum flow rate, Q_{min}, and maximum flow rate, Q_{max};
l) maximum pressure of the gas in the refueling station gas storage, P_{st};
m) maximum fast fill pressure of the gas-fuelled vehicle, P_v;
n) if critical, minimum pressure of the gas, P_{min};
o) if appropriate, nature and characteristics of the gases to be measured;
p) maximum temperature of the gas (1), T_{max};
q) minimum temperature of the gas (1), T_{min};
r) environmental class (see 5.5.2);
s) (3.1.1) the maximum length of the hose.

Notes: 1) The maximum and minimum temperatures of the gas T_{max} and T_{min} are those in the measuring transducer when measuring.

2) The environmental class may be different according to devices of the measuring system, provided each device is used according to its own environmental class. In particular this is applicable to some parts of a self-service device which can be used at different temperatures than the rest of the measuring system.

9 Sealing (7.2)

9.1 General (7.2.1)

Effective sealing shall be provided on all parts of the measuring system which cannot be materially protected in any other way against operations liable to affect the measurement accuracy.

See also 6.14.4, 6.12.1.1 and Annex A

[2] In the scope of this Recommendation "user" is not to be interpreted as the fuel purchasing customer.

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Sealing devices shall prohibit the changing of any parameter that participates in the determination of measurement results (parameters for correction or adjustment and conversion in particular).

Sealing is preferably carried out by means of hardware seals. However, other types of sealing are permitted when these seals provide sufficient integrity, like e.g. electronic seals.

The seals shall, in all cases, be easily accessible.

9.2 Electronic sealing devices (7.2.2)

9.2.1 **(7.2.2.1)** When access to parameters that participate in the determination of results of measurement is not protected by mechanical sealing devices, the protection shall fulfill the provisions of 9.2.1.1 **(7.2.2.1.1)** to 9.2.1.5 **(7.2.2.1.5)**.

9.2.1.1 **(7.2.2.1.1)** Either:

a) Access shall only be allowed to authorized persons, e.g. by using a "password" and, after changing parameters, the measuring system may be put into use "in sealed condition" again without any restriction; or

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

9.2.1.2 **(7.2.2.1.2)** The "password" shall be changeable.

9.2.1.3 **(7.2.2.1.3)** In case of direct selling to the public, the use of only a "password" is not allowed and the measuring system shall be provided with a mechanical sealing device, e.g. access cover protected switch or key switch.

9.2.1.4 **(7.2.2.1.4)** When it is in the configuration mode (a mode in which parameters can be changed), the device shall either not operate or clearly indicate that it is in the configuration mode. This status shall remain until the measuring system has been put into use "in sealed condition" in accordance with 9.2.1.1 **(7.2.2.1.1)**.

9.2.1.5 **(7.2.2.1.5)** For identification, data concerning the latest intervention(s) shall be automatically recorded into an event logger. The record shall include at least:

a) an event counter,

b) the date the parameter was changed, and

c) the new value of the parameter, and

d) an identification of the person that implemented the intervention.

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

Note:

The event logger shall store at least 9 legally relevant interventions. If more than one intervention is stored, and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted

9.2.2 **(7.2.2.2)** For measuring systems with parts which may be disconnected one from another by the user and which are interchangeable, the following provisions shall be fulfilled:

a) it shall not be possible to access parameters that participate in the determination of results of measurements through disconnected points unless the provisions in 9.2.1 **(7.2.2.1)** are fulfilled;

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b) interposing any device which may influence the accuracy shall be prevented by means of electronic and data processing securities or, if not possible, by mechanical means.

9.2.3 **(7.2.2.3)** For measuring systems with parts which may be disconnected one from another by the user and which are not interchangeable, the provisions in 9.2.2 **(7.2.2.2)** apply. Moreover, these measuring systems shall be provided with devices which do not allow them to operate if the various parts are not associated according to the manufacturer's configuration.

Note: Disconnections which are not allowed to the user may be prevented, for example by means of a device that prevents any measurement after disconnecting and reconnecting.

10 Stamping plate (7.2.1)

A plate, referred to as the stamping plate, aimed at receiving the control marks, shall be sealed or permanently attached on a support of the measuring system. It may be combined with the identification plate of the measuring system referred to in 7.1 **(7.1)**.

11 Suitability for testing (New)

The measuring system and, if applicable, its modules shall permit the tests and evaluation according to the applicable clauses in Part 2 of this Recommendation to be performed.
It must be possible to identify modules that have been subject to a separate type examination procedure (meters, printers, etc.).

The design of the instrument shall be such that initial and subsequent verification and metrological supervision can be carried out on site according to the applicable clauses in Part 2 of this Recommendation, without unreasonable effort.

12 Presumption of compliance (5.1.4 amended, generalized)

The type of a measuring instrument according to this Recommendation is presumed to comply with the provisions in this Part 1 of the Recommendation if it passes the examination and tests specified in Part 2 of this Recommendation.

13 Specific requirements for ancillary devices (2.2)

13.1 **(2.2.1)** Ancillary devices may be a part of the calculator or of the meter, or may for example be peripheral equipment connected through an interface to the calculator.

As a rule ancillary devices are optional. However, some may be mandatory required or prohibited by this Recommendation .

Note : Some ancillary devices may or may not be mandatory and/or subject to legal metrology control according to their functionality and/or utilization in the measuring system or according to national regulations.

13.2 **(2.2.2)** When these ancillary devices are mandatory in application of this Recommendation or by national or international regulation, they are considered to be integral parts of the measuring system, they are subject to control, and they shall meet the requirements of this Recommendation.

13.3 **(2.2.3)** When ancillary devices are not subject to control, these devices shall not affect the correct operation of the measuring system. In particular, the system shall continue to operate correctly and its metrological functions shall not be affected when the peripheral equipment is connected or disconnected.

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In addition, these devices shall bear a legend which is clearly visible to the user to indicate that they are not controlled when they display a measurement result visible to the user. Such a legend shall be present on each print-out likely to be made available to the customer.

14 The transfer point (2.5)

14.1 (2.5.1) Measuring systems shall incorporate a transfer point. This transfer point is located downstream of the meter.

14.2 (2.5.3) Two or more delivery transfer points may be permanently installed and operated simultaneously or alternately provided so that any diversion of gas to other than the intended receiving receptacle(s) cannot be readily accomplished or is readily apparent. Such means include, for example, physical barriers, visible valves or indications that make it clear which transfer points are in operation, and explanatory signs, if necessary.

14.3 (2.5.4) When only one transfer point can be used during a delivery, and after the nozzle of the transfer point has been placed back, the next delivery shall be inhibited until the indicating device has been reset to zero.

When two or more transfer points can be used simultaneously or alternately, and after the utilized nozzles of the transfer points have been placed back to their slots, the next delivery shall be inhibited until the indicating device has been reset to zero. Moreover, by design, the provisions of 14.2 **(2.5.3)** shall be fulfilled.

15 Additional requirements for specific modules

15.1 The meter (4.1)

The meter shall meet the following requirements

15.1.1 Metrological specifications of the meter **(4.1.1)**

The field of operation of a meter is to be specified by the manufacturer and is determined at least by the following characteristics:

a) measuring range limited by the minimum flow rate, Q_{min}, and the maximum flow rate, Q_{max};
b) maximum pressure of the gas, P_{max};
c) if critical, minimum pressure of the gas, P_{min};
d) if appropriate, nature and characteristics of the gases to be measured;
e) maximum temperature of the gas, T_{max};
f) minimum temperature of the gas, T_{min}.

The temperature range of the gas shall cover at least + 10 °C to + 40 °C. The rated operating conditions of the meter are the same as those for the complete measurement system. In any case the ranges shall suit the conditions of use.

15.1.2 Additional technical requirements for meters

15.1.2.1 **(4.1.3) Connections between the flow sensor and the indicating device**

The connections between the flow sensor and the indicating device shall be reliable and, for electronic devices, durable, in accordance with 5.8.1, 6.10.2, and 6.10.4 **(5.1.3, 5.3.2 and 5.3.4)**.

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15.1.2.2 (4.1.4) Adjustment device

Meters may be provided with an adjustment device which permits modification of the ratio between the indicated mass and the actual mass of gas passing through the meter, by a simple command.

When this adjustment device modifies this ratio in a discontinuous manner, the consecutive values of the ratio shall not differ by more than 0.001.

This device shall only be used to reduce the measurement error as much as possible.

Adjustment by means of a bypass of the meter is prohibited.

15.1.2.3 (4.1.5) Correction device

Meters may be fitted with correction devices, which are considered to be an integral part of the meter. This implies that the whole set of the requirements which apply to the meter is applicable to the corrected mass. This inn particular concerns the maximum permissible errors like specified in 5.2 **(clause 3)**,

The aim of a correction device is to reduce the measurement error as much as possible.

During normal operation, only the corrected mass values shall be displayed.

The use of this device for adjusting the errors of a meter to values other than as close as practical to zero is forbidden, even when these values are within the maximum permissible errors

Correction is only allowed on basis of actual (measured) parameters. E.g. the correction device shall not allow the correction of a pre-estimated drift in relation to time or mass.

Measuring instruments or devices associated with the execution of the correction, if any, shall comply with the applicable International Standards or Recommendations. Their accuracy shall be sufficient to permit the requirements on the meter be met, as specified in 5.2 **(clause 3)**.

These associated measuring instruments shall be fitted with checking facilities, as specified in 6.10.6 **(5.3.6)**.

15.2 External printersand external memory devices

Additional technical requirements for external printers (New)

External memory or external printing devices (separate modules) connected to the measuring instrument shall have a permanent, non-transferable, and easily readable identification plate or label giving the following information:

a) manufacturer’s trade mark/corporate name;
b) type designation / model number;
c) type approval number;
d) serial number;
e) identification of the measuring instrument(s) of which the measurement results can be printed;
f) details of the electrical power:
   - in case of mains power: nominal mains voltage, frequency and power required;
   - in case of internal removable battery: the type and nominal voltage of the battery;
g) if applicable: specific conditions for use (for instance specific ambient conditions);
h) if applicable: identification of the software (see 6.11).

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ANNEX A

REQUIREMENTS FOR SOFTWARE CONTROLLED COMPRESSED GASEOUS FUEL MEASURING SYSTEMS FOR VEHICLES

(MANDATORY)

The specific software terminology is defined in OIML D 31:2008 Section 3.

A.1 General requirements

A.1.1 Software identification

Legally relevant software of a measuring system and/or its constituents shall be clearly identified with the software version or any other token. The identification may consist of more than one part but at least one part shall be dedicated to the legal purpose.

The identification shall be inextricably linked to this software and shall be:

- presented or printed on command or
- displayed during operation or
- displayed at switching on the measuring system that can be switched on and off.

The software identification and the means of identification shall be stated in the type evaluation certificate.

A.1.2 Correctness of algorithms and functions

The measuring algorithms and functions of the measuring system and/or its constituents shall be appropriate and functionally correct.

It shall be possible to examine algorithms and functions either by metrological tests, software tests or software examination.

A.1.3 Software protection (against fraud)

A.1.3.1 The legally relevant software shall be secured against unauthorized modification, loading, or changes by swapping the memory device. In addition to mechanical sealing, technical means may be necessary to protect measuring systems equipped with an operating system or an option to load software.

A.1.3.2 Only clearly documented functions (see A.3) are allowed to be activated by the user interface, which shall be realized in such a way that it does not facilitate fraudulent use.

A.1.3.3 Parameters that fix the legally relevant characteristics of the measuring system shall be secured against unauthorized modification. For the purpose of verification it shall be possible to display or print the current parameter settings.

Note: Device-specific parameters may be adjustable or selectable only in a special operational mode of the instrument. They may be classified as those that should be secured (unalterable) and those that may be accessed (settable parameters) by an authorized person, e.g. the instrument owner or product vendor.

A.1.3.4 Software protection comprises appropriate sealing by mechanical, electronic and/or cryptographic means, making an unauthorized intervention impossible or evident.

A.1.4.1 Support of fault detection

The detection by the checking facilities of faults as to prevent significant faults to occur may be achieved by software. In such a case, this detecting software is considered legally relevant.

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The documentation to be submitted for type evaluation shall contain a list of parameters which may generate faults and will be detected by the software including the expected reaction and in case necessary for understanding the detection algoritm, its description.

A.2 Requirements specific for configurations

A.2.1 Specifying and separating relevant parts and specifying interfaces of parts

Metrologically critical parts of a measuring system – whether software or hardware parts – shall not be inadmissibly influenced by other parts of the measuring system.

This requirement applies if the measuring system and/or its constituents has interfaces for communicating with other electronic devices, with the user, or with other software parts next to the metrologically critical parts.

A.2.1.1 Separation of constituents of a measuring system

A.2.1.1.a Constituents of a measuring system that perform functions which are legally relevant shall be identified, clearly defined, and documented. These form the legally relevant part of the measuring system.

A.2.1.1.b It shall be demonstrated that the relevant functions and data of constituents cannot be inadmissibly influenced by commands received via an interface.

This implies that there is an unambiguous assignment of each command to all initiated functions or data changes in the constituent.

A.2.1.2 Separation of software parts

A.2.1.2.a All software modules (programs, subroutines, objects, etc.) that perform legally relevant functions or that contain legally relevant data domains form the legally relevant software part of a measuring system. This part shall be made identifiable as described in A.1.1.

If the separation of the software is not possible, the software is legally relevant as a whole.

A.2.1.2.b If the legally relevant software part communicates with other software parts, a software interface shall be defined. All communication shall be performed exclusively via this interface. The legally relevant software part and the interface shall be clearly documented. All legally relevant functions and data domains of the software shall be described to enable a type approval authority to decide on correct software separation.

The interface consists of program code and dedicated data domains. Defined coded commands or data are exchanged between the software parts by storing to the dedicated data domain by one software part and reading from it by the other. Writing and reading program code is part of the software interface.

The data domain forming the software interface including the code that exports from the legally relevant part to the interface data domain and the code that imports from the interface to the legally relevant part shall be clearly defined and documented. The declared software interface shall not be circumvented.

The manufacturer is responsible for respecting these constraints. Technical means (such as sealing) of preventing a program from circumventing the interface or programming hidden commands are not possible. The programmer of the legally relevant software part as well as the programmer of the legally non-relevant part should be provided with instructions concerning these requirements by the manufacturer.

A.2.1.2.c There shall be an unambiguous assignment of each command to all initiated functions or data changes in the legally relevant part of the software. Commands that communicate through the software interface shall be declared and documented. Only documented commands are allowed to be activated through the software interface. The manufacturer shall state the completeness of the documentation of commands.

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A.2.1.2.d Where legally relevant software has been separated from non-relevant software, the legally relevant software shall have priority using the resources over non-relevant software. The measurement task (realized by the legally relevant software part) must not be delayed or blocked by other tasks.

The manufacturer is responsible for respecting these constraints. Technical means for preventing a legally non-relevant program from disturbing legally relevant functions shall be provided. The programmer of the legally relevant software part as well as the programmer of the legally non-relevant part should be provided with instructions concerning these requirements by the manufacturer.

A.2.2 Shared indications

A display or printout may be employed for presenting both information from the legally relevant part of software and other information.

Software that realizes the indication of measurement values and other legally relevant information belongs to the legally relevant part.

A.2.3 Storage of data, transmission via communication systems

If measurement values will be used at a location different from that of measurement or at a later stage than the moment of measurement these possibly need to leave the measuring system or device and be stored or transmitted in an insecure environment before these are being used for legal purposes. In that case the following requirements apply:

A.2.3.1 The measurement value stored or transmitted shall be accompanied by all relevant information necessary for the future legally relevant use.

A.2.3.2 The data shall be protected by software means as to guarantee the authenticity, integrity and, if necessary the correctness of the information concerning the time of measurement. The software that displays or further processes the measurement values and the accompanying data shall check the time of measurement, authenticity, and integrity of the data after having read them from the insecure storage or after having received them from an insecure transmission channel.

The memory device shall be fitted with a checking facility to ensure that if an irregularity is detected, the data shall be discarded or marked unusable.

Software modules that prepare data for storing or sending, or that check data after reading or receiving are considered part of the legally relevant software.

A.2.3.3 When transferring measurement values through an open network, it is necessary to apply cryptographic methods. Confidentiality keys employed for this purpose shall be kept secret and secured in the measuring instruments, electronic devices, or sub-assemblies involved. Means shall be provided whereby these keys can only be input or read if a seal is broken.

A.2.3.4 Transmission delay

The measurement shall not be inadmissibly influenced by a transmission delay.

A.2.3.5 Transmission interruption

If network services become unavailable, no measurement data shall be lost. The measurement process should be stopped to avoid the loss of measurement data.

A.2.4 Automatic storage

When, considering the application, data storage is required, measurement data must be stored automatically when the measurement is concluded, i.e. when the final value used for the legal purpose has been generated.

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The storage device must have sufficient permanency to ensure that the data will not become corrupted under normal storage conditions. There shall be sufficient memory storage for any particular application.

When the final value used for the legal purpose results from a calculation, all data that are necessary for the calculation must be automatically stored with the final value.

A.2.5 Deleting of stored data

Stored data concerning a single transaction and not relevant to maintain for other purposes may be deleted on condition that the transaction is settled;

Only after this condition is met and insufficient memory capacity is available for storage of successive data, it is permitted to delete memorized data when the both following conditions are met:

- the sequence of deletion of data will be in the same order as the recording order (fifo) while the rules established for the particular application are respected;
- the required deletion will start either automatically or after a specific manual operation.

A.3 Software documentation

All program functions shall be explained in the documentation of the measuring system including relevant data structures and software interfaces of the legally relevant part of the software that is implemented in the measuring instrument. All commands and their effects shall be described exhaustive in the software documentation.

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Annex X BIBLIOGRAPHY

(Informative)

(Annex A and B: see Part 2)

[will be updated and completed inlater stage]

Ref.	Standards and reference documents	Abstract (if available !)
[1]	**ISO Guide 99** **ISO/IEC VIM** **OIML V1** International vocabulary of basic and general terms in metrology (1993)	An international agreement on terminology, prepared as a collaborative work of experts appointed by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML. This vocabulary covers subjects relating to measurement and includes information on the determination of physical constants and other fundamental properties of materials and substances.
[2]	**OIML V2** (2000) International Vocabulary of Terms in Legal Metrology (**VIML**)	No abstract available
	GUM (1995????)	
[3]	**OIML D 9** (2004) Principles of metrological supervision	The purpose of this International Document is to provide elements to be considered for developing a model of metrological supervision in Member States which can be used as a basis for the harmonization of metrological supervision at an international level.
[4]	**OIML D 11** (2004) General requirements for electronic measuring instruments	The primary aim of this International Document is to provide OIML Technical Committees and Subcommittees with guidance for establishing appropriate metrological performance testing requirements for influence quantities that may affect the measuring instruments covered by International Recommendations.
[5]	**OIML B 3** (2003) OIML Certificate System for Measuring Instruments (formerly OIML P1), Including Amendment 2006	No abstract available
[6]	**IEC 60068-1** (1988-6), Appendix B (including Amendment 1, 1992-4) Environmental testing. Part 1: General and guidance	Enumerates a series of environmental tests and appropriate severities, and prescribes various atmospheric conditions for measurements for the ability of specimens to perform under normal conditions of transportation, storage and operational use
etc.	etc.	etc.

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