TECH TALK 0089

LIQUID MEASUREMENT FOR TRADE

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1.0 INTRODUCTION

Liquid measurement carried out for the purposes of TRADE (i.e. money changes hands dependent on the measured amount) is strictly regulated. The measuring **system** (not just the clever bits) must be approved for the specific purpose by the governing authority as a design and also checked for accuracy regularly in service by approved license holders.

Normal commercial metering systems used for internal stock control or blending etc. may be of any accuracy standard and need not be approved except to the Operator's specification

This document deals specifically with Trade instruments and the strict rules and regulations surrounding their approval, application and service requirements.

Liquip not only holds approval certificates for system designs (Pattern Approvals) it also is licensed to calibrate and certify systems in the field.

2.0 NMI AUSTRALIA (National Measurement Institute)

(Previously known as NSC, National Standards Commission)

2.1 Functions

NMI is now the National body for both PATTERN APPROVAL and TRADE MEASUREMENT SERVICES (from July 1st, 2010).

Previously NMI was the National body for Pattern Approvals and each State had a Weights and Measures department which acted as "policemen" in the field to check for compliance and regular calibration checks.

PATTERN APPROVAL is the process where companies such as Liquip submit a measuring component or system designed for specific purposes to NMI testing to demonstrate suitability and compliance with all relevant measuring Standards.

This section also issues new or up-dated Standards as necessary. These Standards include performance and accuracy requirements as well as in-service Test Procedures.

Approvals may be for a system (e.g. drum-filling system) or a major component (e.g. electronic indicator) which may be used on any compatible system made by others.

TRADE MEASUREMENT SERVICES is a numerically much larger branch which provides field staff around Australia to monitor compliance in the field. The actual calibration work is carried out by licensed contractors with appropriate expertise (such as Liquip). Licenses are now issued by NMI.

NMI also supervise and sometimes carry out the testing of equipment to issue a REGULATION 13 certificate. Regulation 13 of the National Measurement legislation requires that any instrument used to check another instrument must be an order of accuracy higher and must be physically tested and certified.

Liquip must have Regulation 13 certificates for all volumetric proving vessels, Master Meters, master pressure gauges and master thermometers. All must be re-certified at set intervals and at a significant cost.

Note that NMI look after all legislated measurements in Australia (volume, weight, length) not just liquids. Even breathalyzers.

2.2 Facilities

Head Office & Dry Test Laboratory at CSIRO, West Lindfield.

Wet Test Facility at WorkCover Site at Londonderry.

Trade Measurement Services staff in State capitals branches with National Manager based in Brisbane.

2.3 Personnel (As of May 2010)

NMI — Chief Executive, Dr Laurie Besley.
Liquip historically have not had reason to contact.

NMI — Pattern Approval Manager, Lindfield
Dr. Amanda Rawlinson (Less than a year)
Degrees in Electrical and Electronic Engineering.
Previously managed similar labs in UK.
Primary business contact.
Phone: 8467 3834

NMI — Flow equipment assessment engineer.
Mario Zamora. (Approximately 10 years)
Primary technical contact. Knows Liquip well, very helpful, seems to prefer email contact to telephone: 8467 3833.

NMI — Certificate writer.
Ray Keighley (10 years plus)
Knows Liquip well, close personal relationship, extremely helpful: 8467 3840.

Wet Test Laboratory Manager at Londonderry.
Simon Digman Relatively new)
Based at Lindfield, travels to Londonderry to test as required.
Tests new Patterns and also for Reg.13.
Very approachable at Opening Day.
Phone: 8467 3514

Trade Measurement Services Manager based in Brisbane.
Malcolm Bartlett (Ex-Qld Wts. Measures Dept., been in the industry many years). Never dealt with but has reputation of being fair and reasonable

3.0 STANDARDS IN AUSTRALIA

The NMI website is comprehensive and free. Helpful publications are listed below.

- Certificates of Approval of Measuring Instruments

- General Certificates
  A general certificate is issued to cover trade measuring instruments that are capable of being manufactured to a common standard. In a general certificate a set of design and/or installation parameters are specified.

- NMI P Documents
  An NMI P prefix tells you that the pattern approval document is not mandatory but that it contains guidelines or procedures to help you.

- NMI R Documents
  An NMI R prefix tells you that the pattern approval document is mandatory and that it is based on an OIML international recommendation of the same name and number.

- NMI V Documents (Uniform Test Procedures)
  A NMI V prefix tells you that the document is a test procedure for the verification, certification and in-service inspection of a trade measuring instrument.

3.1 Measurement of Liquids.

Applicable standards as of May 2010 are:

NMI R71	Fixed Storage Tanks for trade use.
NMI R85	Automatic Level Gauges for fixed storage tanks.
NMI R117-1	Measuring Systems for Liquids other than water. See Appendix F.

General Certificate 9/0/B. Vehicle tanks and dipsticks. See Appendix A.

NMI P106 Procedures for Approval. See Appendix C.

3.2 Test Procedures

NMI VO	General Information
NMI V9-1	For Bulk Liquid Petroleum's
NMI V9-2	For Bulk LPG Systems
NMI V16	For Vehicle Tanks

3.3 Regulation 13 Certificates

Required for Master Meters, Volumetric Provers, Master Pressure Gauges, Master Temperature Gauges, Densitometers, Scales.

3.4 Electrical Safety

To IEC International Standards.

4.0 DEVELOPMENT DETAILS

In-Liquip design and test procedures prior to NMI submission.
(Every NMI test and re-test costs $2,000!)

Small but important details to plan ahead:
- Label Information
- Label Material
- Digit & Lettering Height
- Lead Sealing (See Appendix B)

In-House Testing of Prototypes & Pre-Production:
- Radio Shack
- 'Zap' Gun
- Water Proofing (Immersion)
- High Speed – Low Speed Pulsing
- Endurance
- High-Low Temperature Soak
- Temperature Cycling Max-to-Min x 100+Cycles
- Voltage High/Low and Fluctuations
- Current high/Low and Fluctuations
- Vibration

5.0 PROCEDURE FOR APPLICATIONS TO NMI

5.1 Follow NMI publication P106 which includes an application form. See Appendix C. This applies to full systems, components, changes to an existing pattern and testing to Reg 13.

5.2 Identify early in the development which you want to have approved and therefore what samples you will need to prepare for submission. E.g. ticket printer(s), temp probes, remote pulser, battery back-up, etc.

5.3 If going for both NMI & IEC approval with a new electronic device, assess how best to achieve. Simultaneous Applications? Or submit to NMI first to allow sales to commence (and gather field experience) then follow with IEC submission? Australia first then Overseas? Or simultaneous?

5.4 What variants do you wish to approve now? (E.g. Lube Oil). Or leave until later to get sales flowing on mainstream usage?

5.5 Software Versions
Plan the list of software versions for various applications both here and for overseas.

Again, quick and simple to get sales started or include minor variants and sophistications in the initial version?

6.0 BUDGETING FOR NMI APPLICATION

6.1 Examples of Cost
NMI charge by modules. For example, for EMH indicator there are 11 modules at approximately A$2,000 each.

Add more for each failure and re-test. Minor changes may require the equivalent of only one module cost.

6.2 Examples of Time-Frame (Experienced)
From 6 weeks (minor paperwork change) to 18 months (major electronic device which simultaneously is put through electrical safety approval) for each country.

7.0 UNDERSTANDING CERTIFICATES OF APPROVAL

See sample in Appendix D

7.1 Expiry
All certificates require review every 5 years. **It is NMI responsibility to contact Liquip to initiate a review.** Certificate is still valid until the review is requested and completed. (If product is little changed or unchanged, review is generally paperwork only).

7.2 Critical Features to check for Sales applications:

- FIELD OF OPERATION Minimum measured volume of **system**, not just meter.
- MARKINGS Viscosities
- VARIANTS
- DIAGRAMS Fittings required
- See also Appendix B, Tech Talk 86

7.3 Approved Accessories

Only use accessories which are listed in the certificate by name and model number or accessories which have been separately approved and meet the required parameters. For example, a remote pulser which has been approved as a separate component must fit into the speed range, electrical frequency, electrical voltage, etc.

7.4 Diagrams

Certificates for systems include diagrams showing how the system must be constructed for each variant.

Systems must be built exactly to these diagrams including gauge points.

7.5 Fabricator versus Equipment Supplier – Responsibilities

If Liquip supply components to a Fabricator and allows them to placard the system with an Approval plate, it is in theory Liquip's responsibility to ensure the Fabricator has built the system correctly!

8.0 CHANGES TO CERTIFICATES

8.1 Design Change

Significant design changes must be considered in the light of:

- Could it affect the metrology of the instrument?
- Does it affect the identification of the instrument? (Approvals include photographs).
- Has the operation of the instrument changed?

If the answer to any of these is 'yes' or 'may be' then NMI should be notified. An initial approach by email describing the change is often sufficient to allow them to accept the change or to advise us to lodge an application for examination.

8.2 Application Change

If we wish to, for example, extend the viscosity range of a meter to include lube oils then NMI will demand a test-set and carry out testing.

If we wish to include another type of printer, and can provide a full specification, that may well be accepted by inspection without testing.

In the recent case of the introduction of E10 and bio-diesels, the whole industry was granted acceptance within existing certificates but we still had to lodge an application for a variant!

8.3 Software Changes

We must be particularly careful of changes to software and to this end all versions are given a triple set of numbers.

XX:YY:ZZ

The first digits are "Metrology" and changes to this section must not be made unless absolutely essential.

The second digits are "Family" and this is used to distinguish between different models of register (EMH 500 versus EMH 600), and different Standards (Australia vs. USA vs. Canada) etc.

The third digits are "Version" and allow for changes to Company name, Product names and other minor variations.

Notification to NMI is required only for "XX" changes

9.0 OTHER COUNTRIES

9.1 USA

The majority of States of USA operate to a common standard "Handbook 44" issued by the NIST (National Institute of Standards and Technology).

Certificates of conformance are issued under the NTEP (National Type Evaluation Program) which is managed by the NCWM (National Conference on Weights & Measures).

Of the laboratories qualified to test, Liquip use California laboratory. Once the laboratory has successfully completed the testing, it forwards the results to NCWM which issues the NTEP certificate. Approximately 45 States accept this certificate. Several insist on their own evaluation and issue their own certificates. Minnesota has extremely cold winters and requires a unique temp.comp. table for LPG measurement.

As it is now some years since we last obtained a certificate in USA, re-check these details as you go through the process.

9.2 Canada

Canada has a specific regulation for electronic registers called "Weights & Measures Ministerial Specifications SVM-1".

Testing is carried out at the Approval Service Laboratory, Legal Metrology Branch of Industry Canada in Ottawa.

Canadian Weights & Measures are moving towards OIML but our most recent advice (2009) was that they are still using the above SVM-1.

This lab was the most difficult to deal with, every detail presented a query. In particular, the label material took months to get agreement.

N.B. It is several years since then so go into everything with a query on which Standard, which laboratory etc

9.3 Europe

Europe operates under OIML standards.

Until recently all countries operated their own W&M approval systems so even if one laboratory tested to OIML, we had to get a country-specific certificate regardless.

Umbrella organization is WELMEC which stands for Western European Legal Metrology Conference or something. They are drafting Standards for EEC application and the EEC is mandating that if one country issues a certificate, it must be accepted throughout Europe. Reference "Measuring Instrument Directive". I do not know how far this aim has travelled.

The laboratories we have used in the past have been English speaking :

- U.K. Wts & Measures
- NMI Netherlands.

Again, it is a long time ago so start from scratch with local advice from Distributors in Europe about what is required. CE marking may be necessary.

Australian Government
National Measurement Institute

NMI V 16

Uniform Test Procedures for the Verification, Certification and In-service Inspection of Vehicle Tanks

First edition — December 2004

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PO Box 264, Lindfield, NSW 2070

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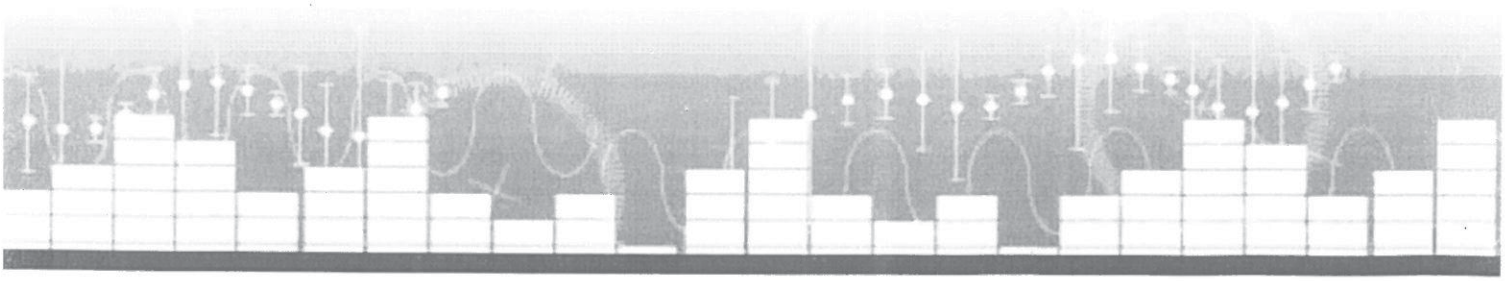
Web page: http://www.measurement.gov.au



Australian Government

National Measurement Institute

NMI R 117-1

Measuring Systems for Liquids Other than Water

(OIML R 117-1:1995(E), MOD)

The English version of international standard OIML R 117-1:1995 *Measuring Systems for Liquids Other than Water* is adopted as the modified national standard with the reference number NMI R 117-1

First edition — January 1977 (Document 101)
First edition, first revision — May 1979 (Document 101)
First edition, second revision — November 1981 (Document 101)
Second edition — July 1988 (Document 101)
Third edition — December 1996 (Document 101)
Third edition, first revision — July 2004 (NMI R 117-1)

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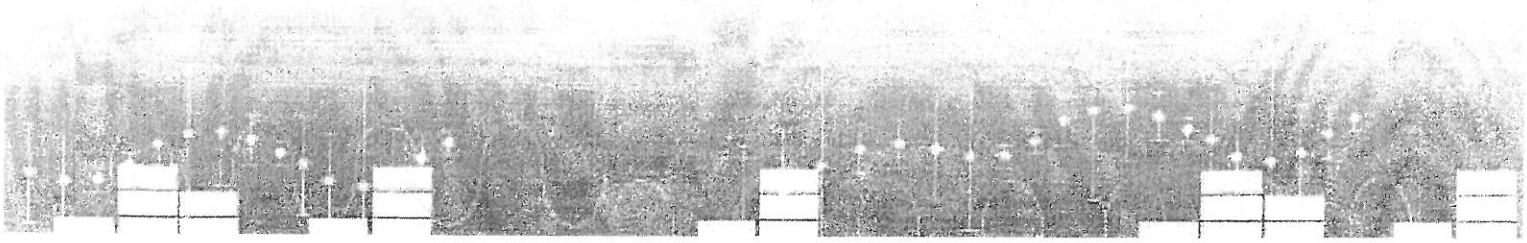

National Standards Commission

General Certificate of Approval

No 9/0/B

Issued under Regulation 9
of the
National Measurement (Patterns of Instruments) Regulations

This is to certify that an approval for use for trade has been granted in respect of

Vehicle Tanks of Capacities 0.5 to 105 kilolitres.

This Certificate is issued upon completion of a review of NSC approval No 9/0/A.

Signed and sealed by a person authorised under Regulation 9 of the National Measurement (Patterns of Instruments) Regulations to exercise the powers and functions of the Commission under this Regulation.

..../2

Subject: Weights & Measures Act & Regulations
Date: Wed, 18 Nov 1998 08:56:00 -0500
From: "Makin, John: LMT" <Makin.John@ic.gc.ca>
To: Miroslaw Lapinski <miroslawl@liquip-nsw.com.au>

Miroslaw:

Please find enclosed R18 & 21 from the W&M Regulations. The full document is available from the Measurement Canada Website at http://mc.ic.gc.ca/ Go to General Information, then go to Regulations, then W&M. You will need the Acrobat Reader.

If you need us to send a hard copy of the W&M Act & Regs, by snail mail or??, please advise.

Regards,

John Makin <<R18&21~1.WPD>>

Part 1.2	**Name:** R18&21~1.WPD **Type:** unspecified type (application/octet-stream) **Encoding:** base64

CANADA

Specifications relating to the design, composition, construction and performance of electronic registers and ancillary equipment incorporated in metering assemblies for liquids and relating to the installation and use thereof.

SHORT TITLE

1. These specifications may be cited as the *Electronic Registers and Ancillary Equipment Incorporated in Metering Assemblies Specifications*.

INTERPRETATION

2.(1) In these Specifications,

"metering assembly"	means a device for use in trade for measuring liquids; (*ensemble de mesurage*)
"metering installation"	means a metering assembly and all equipment necessary for the operation of the metering assembly, and includes the piping, pump, valves and reservoir; (*installation de mesurage*)
"non-resettable register"	means a primary register that is intended for long-term use without being reset to zero; (*enregistreur sans remise à zéro*)
"register"	means any register that incorporates electronic components in order to process signals that correspond to measured quantities; (*enregistreur*)
"registration"	means a displayed or printed value; (*indication*)
"Regulations"	means the *Weights and Measures Regulations*. (*Règlement*)

(2) All other words and expressions used in these Specifications have the same meaning as in the Regulations.

APPLICATION

3. These Specifications apply in respect of registers and ancillary equipment that are intended for use with positive displacement meters for liquids.

DESIGN, COMPOSITION AND CONSTRUCTION

Pulsers for Use with Registers

4. A pulser shall be designed so that a register meets the applicable requirements of these Specifications when the tests described in sections 29 to 31 are carried out.

5. A register shall be equipped with a dual-channel pulser, or with two pulsers, that generates dual pulses corresponding to the liquid flow.

6. A pulser of a register designed to be used in a metering installation that does not incorporate a non-return check-valve shall generate pulses when a reverse flow of liquid occurs through the meter, and the pulse processing system shall distinguish pulses generated by reverse flow from those pulses generated by forward flow.

WEIGHTS AND MEASURES SPECIFICATIONS FOR

Service Station Pumps
Tank Truck Meters
Vehicle Tanks

AS ADOPTED BY THE 1994 NATIONAL
CONFERENCE ON WEIGHTS AND MEASURES

EXCERPTS FROM THE 1995 EDITION OF

NIST HANDBOOK 44

OF THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Published as an Industry Service by

PEI
PETROLEUM EQUIPMENT INSTITUTE

14 PAGES

National Conference on Weights and Measures (NCWM)
National Type Evaluation Program (NTEP)
Application for Liquid Measuring Devices

Date: _____

(For Office Use Only)	*Date Paid:*
Control Number:	*Amount Paid:*

APPLICANT

Company Name: LIQUIP INTERNATIONAL PTY LTD

Address: 13 HUME ROAD, SMITHFIELD

City: SYDNEY State: NSW Zip Code: 2164

Country: AUSTRALIA Representative or Contact: DAVID GREGORY

Telephone (if applicable, include extension): ++ 61297259000 Fax: ++ 61296094739

Email: davidg@liquip-nsw.com.au Web site URL: www.liquip-nsw.com.au

Are you or someone within your company an NCWM Member: ☐ Yes ☒ No

NCWM Member Name: _____ NCWM Member Number: _____

Due at the time of application: For NCWM Members, a nonrefundable application fee of $800 and a certificate processing fee of $150. For NCWM nonmembers, a nonrefundable application fee of $1,200 and a certificate processing fee of $225. All NTEP fees are subject to change; contact NCWM for the latest fee schedules.

As a result of requesting an evaluation and accepting the Certificate of Conformance, the manufacturer implicitly claims that all devices manufactured as the type referenced in the Certificate of Conformance are the same type.

BY SIGNING THIS APPLICATION THE MANUFACTURER AGREES THAT ALL COSTS INCURRED BY NTEP AND/OR PARTICIPATING LABORATORY WILL BE PAID BY THE APPLYING ORGANIZATION.

M D Gregory — Signature

Engineer — Title

20 JULY 2005 — Date

Return application and fees to address below.

Application Payment Method:

☐ Check enclosed (make check payable to "NCWM")

Purchase order will not be accepted.

☐ Visa ☒ Mastercard ☐ American Express

Card Number: [illegible]

Expiration Date: 05/07

Name of Cardholder

MARC HACKWORTH

Please Print

Signature of Cardholder: _____

Publications for Sale:

☐ **Handbook 44 (2003 Edition)**
Specifications, Tolerances & Other Technical Requirements for Weighing and Measuring Devices
Member and Nonmember Price: $40

☐ **Publication 14 - Measuring Devices (2003 Edition)**
Technical Policy, Checklists and Test Procedures
Member/Nonmember Price: $60/$120

☐ **Pub. 14 - NCWM Administrative Policy (2001 Ed.)**
Member/Nonmember Price: $60/$120

Shipping & Handling:
U.S. - 1-2 Publications: $9.95
3-5: $15.95
• *Outside U.S. - at cost*

S1/0/A
20/3/92

National Standards Commission

General Supplementary Certificate of Approval

No S1/0/A

Issued under Regulation 9
of the
National Measurement (Patterns of Measuring Instruments) Regulations

This is to certify that an approval for use for trade has been granted in respect of

Electronic Indicating and Printing Devices for Measuring Instruments.

This Certificate is issued upon completion of reviews of NSC approvals Nos S1/0 and S2/0.

Signed and sealed by a person authorised under Regulation 9 of the National Measurement (Patterns of Measuring Instruments) Regulations to exercise the powers and functions of the Commission under this Regulation.

.../2

Australian Government

National Measurement Institute

NMI V 0

Uniform Test Procedures: General Information

First edition	—	February 2004 (NSC V 0)
First edition, first revision	—	July 2004 (renamed NMI V 0)
Second edition	—	November 2005
Second edition, first revision	—	February 2006

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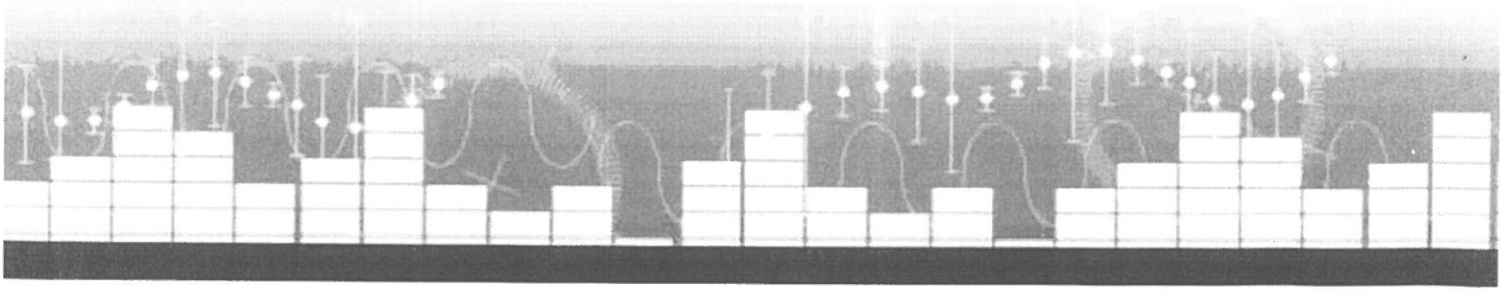

Australian Government
National Measurement Institute

NMI V 9-1

Uniform Test Procedures for the Verification, Certification and In-service Inspection of Bulk Flowmetering Systems. Part 1: Liquid Hydrocarbons (other than LPG)

First edition — September 2008

Bradfield Road, Lindfield, NSW 2070
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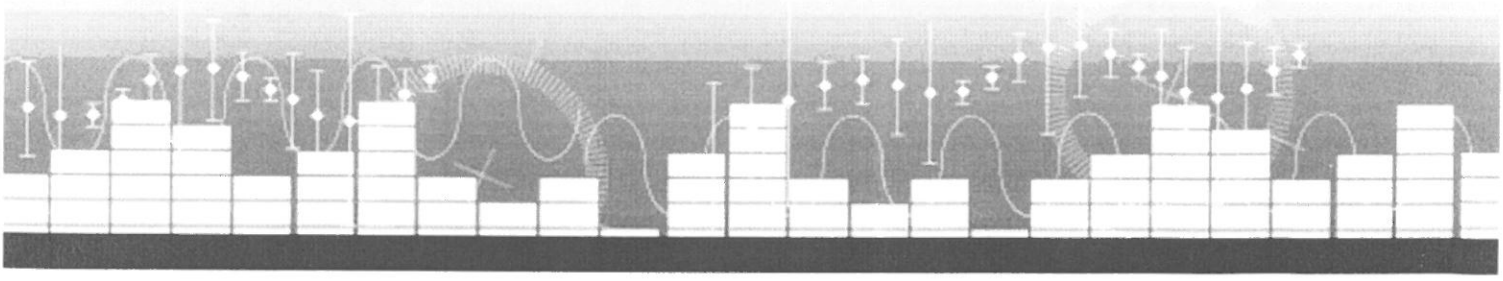

Australian Government

National Measurement Institute

NMI V 9-2
Uniform Test Procedures for the Verification, Certification and In-service Inspection of Bulk Flowmetering Systems

Part 2: Liquefied Petroleum Gas

measurement.gov.au

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TECH TALK 0086
WEIGHTS & MEASURES REGULATIONS
02/09/2008

1.0 Introduction

At present, the state governments of Australia can each have their own detail requirements for W&M: for example, NSW requires lead seals on all critical components which may affect accuracy, Queensland does not.

By 2011, all weights and measures will come under a single department such as NMI and uniform requirements will apply throughout Australia. In preparation, the following documents have been issued by NMI in collaboration with industry:

NMI V0	Uniform test procedures: General information
NMI V9 – 1	Uniform test procedures: Bulk meters, liquid hydrocarbons
NMI V9 – 2	(In preparation) Uniform test procedures: Bulk meters, LPG
NMI V16	Uniform test procedures: Vehicle tanks

Others will follow as they are written.

Following is a summary of current requirements as applied in NSW. There will still be variations on these inter-state, you must know your own local requirements until that happy day when uniformity reigns.
Also, as always, there will be variations in interpretation of detail by individuals in Authority.

2.0 Terminology

The terminology is incredibly confusing and many of those within the government departments and industry will occasionally use an incorrect term – so beware!

"Calibration" is the act of establishing accuracy. "Calibration" is not a legal term

"Certification" and "Verification" are the acts of examining the equipment (including its accuracy) to ensure it complies with all requirements.

"Certification" is reserved for licensed industry personnel (e.g. Liquip certifiers).

"Verification" is reserved for government inspectors.

Certification and Verification Marks (Stamp)

(a) Every system must have only one *"Stamp"* which is the legal display that a certifier or inspector has declared the system to conform with all requirements and accuracy.

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(b) This legal Stamp must have:

- Company (or department) code mark
- Individual's identification code
- Date code

"Sealing Seals" these are all the other lead seals installed on a system to prevent tampering, removal etc. These seals require:

- Company (or department) code mark
- Individual's identification code
- NO date code. This goes only on the main legal *"Stamp Seal"*

A system can have only one legal *"Stamp"* seal but any number of sealing seals.

"In – Service Inspection" is the act of checking a system, including its accuracy, but without disturbing any of the seals. Seals are disturbed only if the system is found to be at fault. If a fault, such as inaccuracy, is found, the main Stamp must be removed or defaced then the fault is fixed and a new Stamp is fitted and marked.

3.0 Specific Examples

3.1 Electronic register with remote pulser

In this case the legal Stamp seal will be on the register with a sealing seal on the remote pulser.

3.1.1 Register faulty

In this case, remove the Stamp seal from the register and the sealing seal from the pulser. Fix or replace the register, re-certify (re-calibrate) and fix and mark a new Stamp seal to the register and sealing seal to the pulser *even though it was not disturbed.*

Records of the repairs must be retained and fees may be payable to W & M.

3.1.2 Pulser faulty

Exactly as above. All seals and the main Stamp must be re-made after repairing and certifying (re-calibrating) even though the register was not disturbed.

3.2 Diptronic with several compartments – current system, no multiple stamping plate

3.2.1 Single compartment faulty

In this case the legal Stamp seal will be on the DIP200 CPU calibrator with sealing seals on each of the compartment sticks and the front cover of the CPU.

The main Stamp mark and the single faulty stick seal must be removed and the stick repaired. That single compartment only must then be re-certified (calibrated) before the new legal Stamp

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is fitted to the CPU calibration plate and a new sealing seal to the single stick. All un-touched sticks retain their (un-touched) sealing seals.
(This is not a strictly correct procedure but as the approval was given on this understanding, it is being treated as allowable until the current review with a Stamping plate system is introduced for new units).
Records of the repair must be retained and fees may be payable to W&M department in some states.

3.2.2 CPU faulty

In this case, the main Stamp seal ***AND ALL OTHER SEALING SEALS*** must be removed. After repairing or replacing the CPU, ***all*** compartments must be re-certified (calibrated) then a new main Stamp fitted to the CPU calibrator plate and new sealing seals to all sticks and the CPU front plate.
Again, records must be retained and fees may be payable.

3.3 Diptronic with several compartments – future system with stamping plate for individual compartments

Future Diptronic systems will require a stamping plate at ground level which will show a symbolic lead seal for each compartment. Details are yet to be received from NMI regarding the operation of this system but it is likely that sealing seals will be required on the stick heads but on the ground-level stamping plate it will have multiple legal Stamps one for each compartment and the CPU calibrator plate will then revert to a simple sealing seal. This will clarify the legal implications of the current single Stamp for the whole system as the new method will treat each compartment as a separate system.
Strictly speaking, if one stick goes faulty at present then the whole tanker should be re-certified (re-calibrated).

3.4 Converting current simple Diptronic to COPS by changing Eprom.

Remove the Stamp seal and the front cover sealing seal to change eprom etc.
When re-assembled, carry out volume reading accuracy checks at several points in all compartments before re-Stamping and re-sealing the CPU. Stick seals are not touched.

Future Diptronic CPU's will contain the COPS software as standard and seals will not need to be broken.

3.5 Visibility of labels

It is a requirement that the W & M inspector or the company certifier record the make, model, serial number and NMI approval number off the data plate plus any other information relevant to the testing procedure.
Some registers have been defected as they had been mounted in such a way that the data could not be read without removing a seal to move the register.

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3.6 Labelling

This is not to do with sealing but is listed as a common omission:

Each register shall show the Minimum Delivery and the Product name.
For Diptronic, in addition the Min Volume and Max Volume.
These labels are frequently omitted and can be cause for an Inspector to fail a system.

DG 02/09/08

(DRAFT NEVER ENACTED)

Leaflet No 23 (a)
May 1997

METHODS OF SEALING AND APPLICATION OF VERIFICATION/CERTIFICATION MARKS TO TRADE MEASURING INSTRUMENTS

This information leaflet indicates National Standards Commission requirements regarding sealing and the application of verification/certification marks to trade measuring instruments. Details regarding information which should be included on seals and/or verification/certification marks is not addressed.

Sealing and Verification/Certification Marks serve differing purposes however they are closely affiliated, and in some cases their functions can be combined. In particular it should be noted that if seals are not suitable for applying verification/certification marks, an additional location for those marks shall be provided. As well, all verification/certification marks shall comply with the Trade Measurement (Measuring Instruments) Regulations, Part II: Verification, Re-verification and Certification.

VERIFICATION/CERTIFICATION MARKS

Verification or certification marks are applied to an instrument to indicate that the instrument has been verified by an officer of the trade measurement authority, or certified by a person licensed to carry out that task.

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Provision shall be made for the application of verification/certification marks either on a stamping plug or on an adhesive label. The following requirements apply:

(a) the marks shall be easily affixed without affecting the metrological properties of the instrument.

(b) the marks shall be visible without moving or dismantling the instrument when in use;

(c) the part on which the marks are located shall not be removable from the instrument without damaging the marks; and

(d) the size of the space shall be sufficient to contain the required verification/certification marks.

If the verification/certification marks are to be applied by way of a destructible adhesive label , a space of at least 25 mm diameter shall be provided for application of the label. If the verification/certification marks are to be stamped into a stamping plug, the area of the stamping plug shall be at least 200mm^2.

SEALING

The purpose of sealing is to provide evidence that the configuration or calibration of an instrument may have been tampered with at some time after the verification or certification of the instrument.

In accordance with a decision of the 10th meeting of the Standing Committee on Trade Measurement (May 1992), the Commission requires provision for the sealing of adjustment devices used to calibrate trade measuring instruments. It should be noted that for some instruments approved prior to this decision there is no provision for sealing, and for some other instruments the provision for sealing may not be in accordance with this leaflet (in particular, in some cases the use of an access code/password has been accepted as a means of electronic sealing, without the use of an alteration counter as described below).

Provision shall be made for sealing those devices and parameters that have a metrologically significant effect and that determine the measurement result. This may include devices and parameters which affect the configuration of the instrument as well as those which affect the calibration.

Sealing requirements for specific types of instrument are generally included in the applicable Pattern Approval Specifications published by the Commission, however in some cases the pattern approval specifications do not address all the methods of sealing which may be acceptable. This leaflet is intended to provide an indication of all the methods which are currently acceptable to the Commission. Contact the Commission for approval of other methods and types of seal not described here.

Details of what requires sealing on each instrument is contained in the technical schedule of its certificate of approval.

The following are types of sealing which are currently acceptable to the Commission.

LEAD PLUG

Sealing may be provided by use of a lead plug securely set below the surface of an undercut hole and so secured that it cannot be removed from the instrument without defacing a mark which is stamped into the lead (see Figure 1). The area to which the mark is to be applied shall be able to accommodate a stamp 4mm in diameter, or, if verification/certification marks are to be applied the area shall be at least 200 square millimetres.

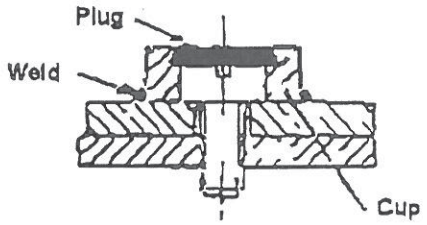

Figure 1. An example of a lead plug

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LEAD PLUG AND SEALING WIRE

The same conditions apply to this method as for the stamping plug with regard to the size and deformation of the mark.

DESTRUCTIBLE ADHESIVE SEALS

In all cases of adhesive seals, which are also used for the verification/certification mark, the mark shall not be premarked on the seal but shall be stamped on using a tool engraved with the inspector's/certifier's mark.

These seals may either be preprinted with the identification of the trade measurement inspector/licensee or this information may be written on at the time of sealing. The date of sealing shall always be written on at the time of sealing and in the appropriate space.

Any destructive adhesive seal which is going to carry a verification/certification mark shall not be premarked but shall be stamped at the time of verification/certification.

These may either be preprinted with the identification of the verifier/certifier or this information may be written on at the time of sealing but the date of sealing shall be written on an appropriate space. The verifier/certifier performing the sealing shall be identified on the label.

Paper Seals:

These consist of a durable paper label which cannot be removed without defacing the verification/certification mark. They may be used in a variety of ways to provide sealing, for example, by:

- Covering a screw which holds the covers of an instrument in place;
- Covering a join or joins in a cabinet or housing to prevent removal of the housing;
- Covering the opening to a recessed switch, adjustment device or activation device (e.g. a push button which must be held down) which permits adjustment or the calibration.

These seals shall be capable of retaining an indelible mark which may be written or stamped (ink pad) without smudging, blurring or loss of detail.

Metal Seal:

These are similar to a paper seal except that they are made of thin foil with an adhesive backing and may be used in a similar fashion to the paper seal.

Some types of metal foil labels will not accept a stamp and have less use in the field; these should be restricted to a use where they do not need to carry a verification/certification mark, for example inside an instrument to cover an adjustment, switch or access hole.

Plastic Seal:

Similar labels to the paper seal are available in plastic, notably thin film mylar, where the information on the label is destroyed if an attempt is made to remove the label.

These have less use in the field as it is difficult to stamp the surface once installed and should be restricted to a use where they do not need to carry a verification/certification mark, for example inside an instrument to cover an adjustment, switch or access hole.

PLASTIC DISK AND SEALING WIRE

This type of seal is basically the same as its lead and wire seal, but using deformable disks of a plastic material in place of the lead seal. These may be used with specially prepared plastic "wire supplied with the seals or , in some instances, with a metal wire.

Currently the only seal of this type approved by the Commission is a Harmet seal (see Figue 2). It is composed of a plastic disk and sealing wire which may be made of either plastic or metal.

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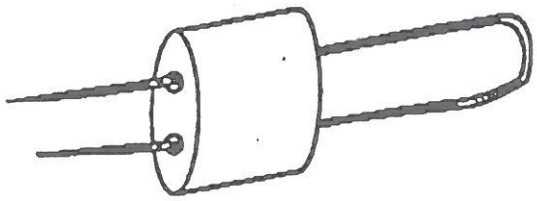

Figure 2. A Harmet seal.

WIRE AND FERRULE OR TAG SEAL

This type of seal is again similar to the lead and wire seal, but utilises a hardened steel wire which is passed through the sealing points and terminated by passing the ends through a copper ferrule which is then crimped using a special tool. The upper and lower jaws of the tool can each mark a three digit code. Additional security can be achieved by using the ferrule with a tag which can be prestamped with an identification code.

Currently the only seal of this type approved by the Commission is known as a "Maun" seal.

Wire and ferrule or tag seals are not suitable for applying verification and certification marks. Instead use a destructive label as described above.

ELECTRONIC SEAL

When an instrument may be calibrated by entering calibration data via a means such as a keyboard, magnetic card etc, this function shall be inhibited by an additional device which can be sealed by one of the mechanical sealing devices described in this information leaflet.

Alternatively, sealing may be provided by a combination of access code, event counter and verification/certification mark in accordance with the requirements given below.

(a) Access by authorised persons shall be protected by some form of physical key or a password or access code (e.g. a four digit code).

(b) Any access to alter protected parameters shall be automatically recorded (e.g. by means of a counter which automatically increments when access is initiated).

(c) The record shall be readily accessible by a simple action (e.g. by display of the counter when a button identified as being for this purpose is pressed, or during the indication check).

(d) The record shall be readily identifiable as such and shall not be easily confused with other indications of the instrument.

(e) A reference record in the same form as the incremental record shall be permanently marked on the instrument to indicate that the parameters have been accessed since the last verification (e.g. the reference record could be associated with the verification mark).

(f) The record shall not repeat in a sequence of less than 999 alterations. It shall also persist reliably for a period of at least two years (unless it is overwritten by a further alteration). The record shall persist through tests for influence factors and disturbances specified in the recommendation.

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Australian Government

National Measurement Institute

NMI P 106

Approval and Certification Procedures for Measuring Instruments Suitable for Use for Trade and any Other Legal Purpose

Tenth edition — November 2007

Note: All of our certificates of approval are available on-line at www.measurement.gov.au/patternapprovalcertificates

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CONTENTS

1. INTRODUCTION

The *National Measurement Act 1960* provides the legal basis for examining and approving patterns (designs) of measuring instruments suitable for use for trade and any other legal purpose. This document provides administrative details of the procedure for applying for the pattern approval of such instruments.

NMI's Pattern Approval Laboratory is able to test and approve:

- non-automatic weighing instruments;
- liquid measuring instruments;
- spirit dispensers;
- length measuring instruments;
- area measuring instruments;
- milk tanks;
- load cells;
- digital indicators;
- weighing-in-motion systems;
- belt weighers;
- totalising hopper weighers;
- automatic catchweighing instruments;
- multi-dimensional instruments;
- automatic tank level gauges;
- fuel dispensers for motor vehicles;
- fuel dispenser control systems;
- fuel dispenser calculator/indicators;
- liquefied petroleum gas systems;
- compressed natural gas systems;
- grain protein measuring instruments;
- utility meters (electricity meters and water meters)[1]; and
- evidential breath analysers[1].

The majority of instruments NMI approves are instruments suitable for use for trade.

Instruments suitable for use for trade

Unless a class of instrument has been specifically exempted, the Uniform Trade Measurement Legislation in each State and Territory requires that every measuring instrument in use for trade be of a pattern approved by the Chief Metrologist.

A certificate of approval is issued for each pattern of instrument after it has satisfactorily completed its approval testing.

It is an offence for an instrument to be verified or certified for use for trade, which includes the determination of excise or duty, which is not of a pattern approved by the Chief Metrologist or specifically exempted from this requirement.

Trade measurement authorities can provide information on whether the instrument comes under the definition of in use for trade.

Instruments suitable for any other legal purpose

In addition to issuing certificates of approval for instruments in use for trade, the Chief Metrologist can issue certificates of approval for instruments used for any other legal purpose.

If a measuring instrument is required by a government authority to be used for regulatory purposes, it is considered to be a legal measuring instrument and the pattern of such an instrument may need to be approved for conformance with specified requirements.

2. DEFINITIONS

In this document, unless the contrary intention appears:

Applicant means the person or persons (whether corporate or natural) who is, or are, applying for approval of a measuring instrument for use for trade and any other legal purpose.

Family of measuring instruments comprises instruments of the same design and that use the same measuring technique to measure the same physical quantity. All of the family are subject to the same metrological requirements (e.g. accuracy class, maximum permissible errors) but may be of different capacities and sensitivities and may vary in other operating and performance characteristics.

Measuring instrument means a thing by means of which a measurement of a physical quantity may be made or a module of such a thing. The measuring instrument may include additional related functions.

[1] NMI appoints other authorities to **test** utility meters and evidential breath analysers (partial testing). However NMI **approves** the instruments.

Module means an element of a measuring instrument that performs a specific metrological function that can be separately examined and is subject to specified partial error limits.

Pattern refers to those characteristics of the design and operation of a measuring instrument that uniquely defines the instrument and its metrological characteristics.

Variant is a physical change made to the pattern of an instrument.

Variation is a change made to the approval documentation which describes the pattern and variants.

3. PROCEDURE TO FOLLOW WHEN APPLYING FOR APPROVAL

When applying for a certificate, complete the application form (available on our website). A submission will not proceed until the necessary instruments (see clause 7.2) and documentation (see clause 3.1) required for pattern approval testing are received.

When accepting an application for approval, it is assumed that the performance specifications and range of operating conditions included in the application form are those for which the manufacturer has designed the instrument to comply with Australian pattern approval specifications.

See clause 9 for the costs associated with pattern approval.

Requests for minor changes to an approval certificate shall be made in a letter addressed to the Chief Metrologist (see clause 4.10).

3.1 Documentation to Accompany Applications

The application form has provision for noting documentation provided. The applicant shall advise us if these documents have been supplied for a previous application and shall detail their relevance to the current application.

The following documentation should accompany each application:

(a) technical information such as working drawings, functional drawings, electrical diagrams, piping diagrams, operating and service manuals;

(b) a declaration of safety:

  (i) for liquefied petroleum gas flowmeters there shall be a Standards Australia certificate of compliance;

  (ii) for other flowmeters there shall be a declaration that the instrument has been designed and constructed to the relevant Australian safety standards and that an application for a Standards Australia certificate of compliance has been lodged; and

  (iii) for all other instruments there shall be a declaration that the instrument has been designed and constructed to the relevant Australian safety standards.

(c) sufficient specifications, photographs and descriptions for a complete understanding to be obtained of the construction and method of operation of the instrument and its variants;

(d) a completed test report where available;

(e) for measuring instruments covered by part VA of the National Measurement Act or National Measurement Regulations test reports in an approved form from the approving authorities which have conducted the approval tests.

All descriptive material shall be in English. Illustrations intended for inclusion in the certificate of approval shall comply with the requirements specified in clause 8.3.

All documentation shall be retained by NMI.

3.2 OIML Certificate System

The International Organisation of Legal Metrology (OIML) has developed a certificate system for measuring instruments. The aim of the system is to issue a certificate of conformity for a measuring instrument to testify that the instrument conforms to the requirements of the relevant OIML recommendations applicable within the system.

National approval authorities may take the certificate of conformity and its associated test report into consideration in providing national pattern approval certificates.

An applicant requiring an approval based on an OIML certificate of conformity must provide:

(a) a certificate of conformity issued by an OIML issuing authority (the issuing authority must be accredited under a scheme recognised by Australia and must perform satisfactorily in interlaboratory comparisons); and

(b) a completed pattern evaluation report.

As these conditions are not yet possible for all instruments, the applicant should contact NMI regarding the use of this system.

Pattern evaluation reports, however, will be accepted as a guide to NMI's own testing.

NMI is an OIML issuing authority for the following categories of measuring instruments:

(a) continuous totalising automatic weighing instruments;

(b) automatic catchweighing instruments;

(c) metrological regulation for load cells;

(d) non-automatic weighing instruments;

(e) automatic rail weighbridges; and

(f) measuring systems for liquids other than water.

If you require an OIML certificate you should ask for it when you make your application for pattern approval. Additional fees are applicable.

4. CERTIFICATES ISSUED

Certificates of approval of measuring instruments are issued under Regulation 60 of the National Measurement Regulations.

The certificates of approval described in clauses 4.1 to 4.8 usually comprise three sections:

(a) a certificate which consists of the advice of approval together with the conditions of approval;

(b) a technical schedule (which may include illustrations) which describes the pattern and any variants; and

(c) a test procedure which specifies the tests to be performed for verification or certification of instruments conforming to the pattern and its variants and the applicable maximum permissible errors.

A new certificate of approval and technical schedule are issued for each variant to the pattern subsequently approved.

Fees are charged in accordance with our schedule of fees (see clause 9).

Published certificates may be viewed at www.measurement.gov.au/patternapprovalcertificates.

4.1 Certificate of Approval of a Pattern

A certificate of approval attests that the pattern of the complete measuring instrument is suitable for use, namely a sample instrument has been examined and has been found to comply with Australian pattern approval specifications. A certificate of approval may be provisional (see clause 4.3).

The Chief Metrologist sets a review date, which is nominally five years from the date of the approval or one year for provisional approvals (see clause 5).

4.2 Supplementary Certificate

A supplementary certificate approves the pattern of a module of a measuring instrument as distinct from the whole instrument. For example, a flowmeter calculator/indicator, a load cell or a digital indicator may be approved without

necessarily examining or referring to a complete measuring instrument.

A supplementary certificate specifies the conditions under which the module shall be fitted to the complementary part of an approved measuring instrument. For example a load cell shall be limited to use in baseworks of approved weighing instruments in which the force applied by the load is within a specified range; a flowmeter calculator/indicator shall be limited to those approved flowmeters in which the volume per revolution or pulse output of the meter is compatible with the calculator/indicator input.

Before a supplementary certificate is issued, a sample of the module shall be examined for compliance with Australian pattern approval specifications. A supplementary certificate may be provisional (see clause 4.3).

The following conditions apply to the use of modules approved under supplementary certificates:

(a) an instrument cannot be constructed from a combination of modules approved in supplementary certificates; the pattern of the instrument to be modified by the addition of a module approved under a supplementary certificate must have a full certificate of approval (as in clause 4.1);
(b) a replacement module shall have a supplementary certificate which permits the interchange of this module with the equivalent module specified in the pattern or variants;
(c) the module being replaced shall have been approved under a supplementary certificate for it to be able to be replaced by an alternate module; exemption to this requirement will only be considered in exceptional circumstances; and
(d) modules of instruments which have been approved as an integral part of an instrument cannot be exchanged with any alternate module unless expressly provided for in the certificate of approval for the instrument.

4.3 Provisional Certificate

A provisional certificate is a particular form of a certificate of approval or a supplementary certificate applicable to patterns of instruments or modules of instruments, which, due to their large size, installation requirements or other features, cannot be fully examined in the laboratory and therefore require field testing, for example large bulk flowmeters.

A laboratory examination (not necessarily complete) of the whole pattern or those modules which can be tested by NMI is required to assess their compliance with Australian pattern approval specifications, together with regular field reports of performance. The field reports shall be arranged by the applicant and forwarded to NMI. The provisional certificate may be withdrawn if these reports are not received as required.

Provisional certificates may also be used for patterns of instruments on which field trials are necessary to assess consumer reaction and suitability under particular operating conditions. In this case two applications shall be made; one for the certificate of approval and one for a provisional certificate nominating a limited number of instruments and location details. Each application attracts its own fees.

The applicant, in agreeing to a provisional certificate, accepts the risk involved, because in the event of unsatisfactory performance a provisional certificate is normally withdrawn and any instrument verified or certified under that certificate shall no longer be legal for trade use (see clause 4.12).

A provisional certificate is usually valid for twelve months. After this period, if field evaluation proves satisfactory and all conditions of approval have been met, the provisional status is removed and the normal review period is set based on the original date of the approval (see clause 5).

4.4 General Certificate

A general certificate is issued to cover measuring instruments which are capable of being manufactured to a common standard. In a general certificate the Chief Metrologist specifies a set of design and/or installation parameters.

General certificates are issued:

(a) for particular categories of simple measures which are submitted directly to trade measurement authorities for verification without examination by NMI, for example masses, simple measures of length; and

(b) to complement certificates of approval by providing general data and calculations, installation requirements and other information pertinent to the approval; such general certificates do not replace the need to obtain a certificate of approval for a pattern of a measuring instrument but are intended to remove the need for numerous and repetitive variants.

4.5 General Supplementary Certificates

General supplementary certificates are issued to supplement certificates of approval by approving ancillary or peripheral modules, for example printers and electronic cash registers; these devices are approved under general supplementary certificates.

4.6 Certificate of Approval of an Instrument

An instrument certificate relates to a single, or small number of, particular instruments (as distinct from a pattern of an instrument) whose performance is suitable for particular operating conditions outside the scope of Australian pattern approval specifications, or is a new type of instrument for which no pattern approval specifications exist. Each instrument is examined and identified by location and/or serial number.

The site examination required in the approval procedure may (at the discretion of the Chief Metrologist) be carried out in conjunction with verification of the instrument by a trade measurement authority.

4.7 Conversion Certificate

A conversion certificate allows the applicant to convert instruments covered by a certificate of approval to a different type of instrument if that conversion is in accordance with a relevant general certificate, for example a mechanical platform weighing instrument could be converted to a lever/load cell platform weighing instrument in conjunction with General Certificate 6B/0.

A conversion certificate describes a pattern as examined by NMI and a general certificate allows variants to that pattern.

A conversion certificate does not allow new instruments to be manufactured to the pattern, however, it does allow existing instruments to be converted to a different type, or approved load cells or certain approved components to be exchanged.

4.8 Variation to a Certificate of Approval

A variation to a certificate of approval is required when the applicant changes a component of, or adds a component to, a pattern, thereby altering the approved performance or operation of the pattern, for example a change in capacity of a measuring instrument. However, to be considered a variant to the pattern rather than a separate pattern, the arrangement of the components of the instrument and the measuring element must be substantially of the same design as that of the approved pattern.

When applying for a variant it is advisable to assign the instrument with a model number which differs from the pattern and other variants.

On approval of a variant to the pattern, the

Chief Metrologist issues a variation stating the changes applicable to the pattern and any subsequent effect on the operating conditions. If there is any doubt as to whether there is a need for a variant to be obtained NMI should be contacted. An application for a variation shall not be accepted for a cancelled, expired or withdrawn certificate.

4.9 Interim Certificate

An interim certificate is issued on completion of a successful approval examination (see clause 8.1). An interim certificate will be accepted by trade measurement authorities for up to three months to permit verification or certification of equipment whilst the final certificate is being prepared. See clause 4.10 on extension of validity of interim certificates. Interim certificates do not include a technical schedule but do include some technical details and may include a test procedure. It is the responsibility of the applicant to comply with all conditions of approval listed in the interim certificate, including:

(a) making special arrangements with each trade measurement authority to have instruments covered by an interim certificate verified or certified, before the final certificate is issued; and

(b) making any changes required to instruments where any differences occur between the final certificate (and technical schedule) and the interim certificate, and to accept the commercial risks involved.

4.10 Notification of Change to Certificates of Approval

Requests for minor changes to an approval document shall be made in a letter addressed to the Chief Metrologist.

Minor changes to approval documents such as changes of address or markings, clarification of descriptive material, alteration to periods of validity and other administrative matters, shall be notified by means of a notification of change (change notice). A notification of change may be issued for any type of certificate.

Where a notification of change is the most convenient method of altering the documentation, either to include a variant or due to applicant error, the applicant will be required to pay a fee in accordance with our schedule of fees (see clause 9).

4.11 Cancellation of Certificate of Approval

A cancellation certificate may be issued to cancel an approval or series of approvals. After the cancellation date, no new instruments conforming to the pattern or variants described in the certificate may be submitted for verification or certification. However existing instruments may continue in use at the discretion of the trade measurement authority. When an approval has been reviewed and a new approval issued a cancellation certificate is issued for the old approval and new instruments submitted for verification have to comply with the requirements of the new approval.

4.12 Withdrawal of Certificate of Approval

All instruments shall be removed from use for trade after a withdrawal certificate has been issued for the certificate under which they were approved, for example, if an instrument does not comply with the metrological criteria required by Australian pattern approval specifications, or if an instrument is not manufactured or used in accordance with the approved pattern as described in drawings and specifications lodged with NMI.

4.13 Instrument Test Report

An instrument test report is based on the performance of a module or a complete instrument and may or may not make reference to Australian pattern approval specifications. An instrument test report generally involves accuracy tests only,

performed under the conditions specified by the applicant. Instrument test reports are only available to the applicant.

An instrument test report does not imply approval for trade use but may be useful for the designer, manufacturer or user to assess the performance of the equipment, for example a load cell manufacturer may wish to assess the performance of a load cell for engineering, scientific or promotional purposes. Such a test report is similar to that issued by a NATA-registered laboratory. NATA endorsed reports can be issued for some instruments.

4.14 Regulation 13 Certificate

Under Regulation 13 of the National Measurement Regulations, a certificate can be issued if an instrument is used as a reference standard of measurement in the verification/certification of a measuring instrument in use for trade or used for legal purposes. Regulation 13 certificates can be issued for some instruments.

Note: Regulation 13 certificates were known as Regulation 80 certificates until 1 October 1999 when the National Measurement Regulations 1999 came into effect.

5. REVIEW OF APPROVALS

Certificates of approval specify a review date five years after approval. This period is set to allow instruments manufactured to the original pattern to be sold without having to be rechecked by NMI. If after five years, the applicant still intends to sell the equipment, the applicant must apply for a review of the certificate.

When the application for a review is received it is assessed by NMI to determine whether or not any of the instruments covered by the certificate are required for review testing. If an instrument requested for review is not received within one year of the request, or if the instrument fails its review and the fault cannot be rectified, then the certificate of approval will be cancelled (see clause 4.11).

If the instrument submitted successfully passes the assessment and/or tests, a reviewed certificate of approval or a notification of change is issued and the review period is extended for another five years.

The review criteria apply to the pattern and variants covered in the certificate of approval. The review date is based on the approval date of the pattern and will apply to the pattern and all variants even if the date of approval of a variant is later than that of the pattern.

If a new certificate is issued after a review then a cancellation certificate is also issued which prevents any new instruments manufactured using the original approval from being sold. Once cancelled, instruments in use in the field under the original approval may remain in use for trade at the discretion of the trade measurement authority.

Also the Chief Metrologist will review an approval where submission is made by a trade measurement authority under Regulation 65 of the National Measurement Regulations. This may arise as a result of the detection of non-compliance of an instrument in the field and requires that a sample instrument be examined. If the non-compliance is substantiated, the certificate may be withdrawn and all instruments shall be removed from use for trade.

6. CONSULTATIVE SERVICE

NMI will provide advice on technical matters relating to trade or legal measuring instruments. Fees may be charged to cover our costs for the following services:

(a) advice to industry and government authorities, who are users rather than applicants, on tender specifications or equipment involving trade or legal measurement submitted for tender;

(b) advice on test methods and equipment necessary for testing equipment for trade or legal measurement;

(c) overviews of the design and operation of a production pattern, or a proposed pattern, to ensure that there are no obvious conflicts with Australian pattern approval specifications or particular problems which may be posed by testing;

(d) visits to industry prior to the submission of an application for approval of an instrument for trade or legal measurement;

(e) assistance with field trials of instruments for trade or legal measurement;

(f) an interpretation or explanation of NMI examination results as they relate to an instrument; and

(g) the reappraisal of technical decisions arising from an examination where there is a difference in emphasis or design philosophy between the applicant and the Chief Metrologist.

NMI also provides training and assistance for potential applicants unfamiliar with national or international test procedures.

7. THE SAMPLE INSTRUMENT

7.1 Assessing Instruments

NMI evaluates the application for pattern approval and determines what testing is required, what additional instruments and/or modules need to be tested, identifies the pattern and determines the variants applicable to the application. This assessment may change as a result of testing.

When it is not possible to determine these factors, or if NMI considers it advisable to discuss points relating to the application before proceeding to an approval examination, the applicant shall make use of our consultative service.

If it becomes apparent that the instrument is not acceptable for approval prior to tests commencing, the applicant will be notified. The applicant may be advised to make use of the consultative service and will be charged for the assessment already undertaken at the applicable hourly rate, in addition to any charges applicable to any consultation. If the applicant decides not to continue with the application, the applicant shall be charged for the assessment undertaken to that date plus the application fee.

7.2 Instruments Required for Test

The following guidelines are used to determine what instruments covered by the application will be tested. The guidelines also apply to modules when the application is for an approval of a module.

(a) If the application for approval covers a single pattern of an instrument, then one sample instrument (unless stated otherwise for a particular type of instrument or module, e.g. load cells) is required for testing.

(b) If the application for approval is for a family of instruments, more than one sample instrument will be required for testing. Unless the performance characteristics of the instruments overlap significantly, at least the following instruments shall be tested:
   (i) the instrument with the lowest performance characteristic(s);
   (ii) the instrument with mid performance characteristic(s);
   (iii) the instrument with the highest performance characteristic(s).

   Note: Performance characteristics include capacity of weighing instruments, flow rate of flowmeters, rated operating conditions (e.g. temperature) and value of the scale interval of a load cell or weighing instrument etc.

   The application form requires the performance characteristics of the family of instruments to be specified. The sample instruments will be tested to establish that they perform correctly within the specified characteristics. By specifying these characteristics, the applicant is

stating that instruments can be manufactured to perform consistently within the limits specified. The performance characteristics specified should therefore be carefully chosen as any request to change them after determining the test results implies that the manufacturer does not have adequate quality control over the products.

(c) If an instrument in the family has additional metrological or operational functions (e.g. tare, price computing) a sample of this instrument will also be required for testing.

(d) Where possible instruments will be selected with appropriate combinations of performance characteristics and operational functions to minimise the number of instruments required for testing.

(e) Where possible an instrument will be tested as a single device at NMI for all influence factors and disturbances. However when this is not possible (due to say the instrument's capacity being too large) then the modules of the instrument will be tested separately at NMI for all influence factors and disturbances. A test of the instrument in the field under field conditions will then be necessary to complete the evaluation.

A supplementary certificate will not be issued for the modules tested unless a separate application for such a certificate has been made by the applicant.

(f) If the application requires that the various modules of the instrument may be replaced by other modules, it will be necessary to test the modules separately as well as testing a complete instrument. Supplementary certificates may be necessary for each module in some cases. The application shall state the requirements.

(g) If the application for approval is for variant instruments of the family to be added to an existing approval, then the guidelines for submission of instruments for test follow the above (see definitions as specified in clause 2 for what instruments are included in a family of measuring instruments).

If the variant only covers a module of the pattern, then only that module needs to be submitted for testing.

7.3 Examination Site

The examination is either carried out at NMI's premises, or at a site selected by NMI in consultation with the applicant. Measuring instruments covered by part VA of the National Measurement Act or National Measurement Regulations may be examined by approving authorities (details of which are available on our website).

The applicant shall be responsible for:

(a) the delivery, erection, calibration and disassembly of the instrument;

(b) the provision of any facilities as determined by us that are required for testing; and

(c) site costs (see clause 9).

7.4 Retention and Removal of Instruments

NMI may hold the sample instrument, or any of its modules, for identification purposes, as long as any instrument conforming to the pattern is in use for trade. This applies particularly to modules which incorporate the measurement or computational functions of the instrument.

The applicant shall be responsible for packaging and removing the instruments and/or parts of instruments from NMI's premises (or the agreed examination site) when notified that the instruments are no longer required.

NMI reserves the right to pack and return to the applicant, at the applicant's expense, instruments (or parts thereof) not removed from NMI after three months from the date of any such notification.

8. APPROVAL PROCEDURE

8.1 Interim Certificate

On completion of a successful examination an interim certificate (see clause 4.9) is prepared and an approval number is allocated to the pattern. The interim certificate is sent to the applicant and to each trade measurement authority to allow instruments to be installed and verified or certified before the final documentation is issued. The interim certificate may also include testing procedures, in addition to those given for verification, and certification in the uniform test procedures (those publications with an NMI V prefix).

8.2 Certificate Documents

In addition to the interim certificate, draft documents including a certificate of approval, technical schedule and test procedure are sent to the applicant for comment and agreement. At the same time the applicant is asked to provide any illustrations necessary for inclusion in the technical schedule (see clause 8.3).

The certificate of approval nominates the pattern and variants (if any), applicant's name, manufacturer, date of approval, review date, approval number and conditions of approval. The pattern is described in the technical schedule and the test procedure specifies the tests necessary to confirm the performance of the instrument.

Once illustrations (if requested) and written agreement to the draft documents are received from the applicant, the final certificate of approval, technical schedule and test procedure are issued.

8.3 Illustrations for Approval Documents

All illustrations (drawings and/or photographs) used in the technical schedule must comply with the requirements detailed below. Failure to provide correct illustrations may result in delays and additional charges.

The illustrations shall be labelled and show the complete system and its major components. An explanation should be provided if the labelling is not the same as that used in the technical schedule.

Illustrations may be supplied electronically (as a TIFF or JPG file) or as hard copy (see clauses 8.3.1 and 8.3.2).

Upon request from an applicant, NMI will arrange to have photographs and drawings prepared for inclusion in the technical schedules. The applicant shall pay the full cost of any work.

8.3.1 Drawings

Where drawings are to be included in the technical schedule, two copies of each drawing shall be supplied, one with and one without labelling, and these shall:

(a) be approximately 210 × 295 mm (A4);

(b) generally follow good drawing practice principles, e.g. as set out in the relevant Australian standard;

(c) consist of black lines on white paper, and be original drawings or high quality prints;

(d) include only those details relevant to the approval;

(d) not be dimensioned unless NMI so directs; and

(e) have one copy clearly and unambiguously identify the major components of the instrument.

8.3.2 Photographs

Photographs shall:

(a) have the object of the photograph substantially filling a rectangle of approximately 130 × 205 mm and not less than 100 × 180 mm so that they may be printed without reduction or enlargement;

(b) be in sharp focus and of good contrast;

(c) have a neutral or contrasting background; and

(d) include only those details relevant to the approval.

8.4 Distribution of Approval Documents

The applicant receives a copy of the certificate of approval which includes the technical schedule and test procedure (preferably by email) and at the same time a copy is placed on our website.

Test reports are only made available to the applicant.

8.5 Ownership of Certificates

The certificate of approval and associated documentation remain the property of NMI and may not be sold, transferred, altered or disposed of in any manner whatsoever by the applicant, without the prior written approval of NMI.

The person to whom a certificate is to be sold or transferred shall, prior to approval of the sale or transfer, notify NMI of their acceptance of the conditions of approval as detailed in the certificate including the responsibility for compliance for new instruments, manufactured, supplied and/or installed by them.

8.6 Responsibility for Compliance of Instruments with the Certificate

It is the responsibility of the applicant nominated in the certificate of approval, whether as agent or manufacturer, to ensure that all instruments manufactured to a pattern and installed for trade use, comply with the certificate of approval, its technical schedule and the drawings and documentation retained by NMI. Instruments shall not deviate in any significant structural or metrological fashion from the sample instrument, or its approved variants.

It is an offence for a person, other than the applicant or an agent nominated to NMI in writing by the applicant, to mark an approval number on any instrument for which they do not hold the certificate or an authority to manufacture (or import) from the applicant, thereby purporting that it complies with that certificate. This may lead to prosecution under both State/Territory Trade Measurement Legislation and section l9B of the *National Measurement Act 1960*.

However, a supplier/installer may copy an approval number from one part of an instrument to a central nameplate, for example when a dial is replaced with a digital indicator and the basework number which appears on the dial has to be transferred to the digital indicator.

8.7 Responsibility for Compliance following Modification or Repair

Anyone who replaces metrologically significant components with alternate components, replaces approved modules with other approved modules, repairs an instrument or makes other modifications, is responsible for the metrological performance of that instrument whether or not they are the applicant for the instrument (or the approved modules) as listed in the certificate of approval.

The applicant who holds the certificate of approval remains responsible for all other parts of the instrument.

8.8 Repairs to a Measuring Instrument of a Cancelled Certificate

Where a certificate of approval has been cancelled but not withdrawn (see clauses 4.11 and 4.12), instruments may remain in use for trade at the discretion of the trade measurement authority. This may lead to a situation where the instrument requires maintenance.

Such repairs may be made using a supplementary certificate, provided that the repairs are limited to replacing mechanical parts, structural parts and indicating devices (digital for digital, mechanical for mechanical but not digital for mechanical other than as covered by General Certificate 6B/0).

While replacement parts should be identical to those being replaced, this may not be possible due to the age of the instrument. Where original parts are not available, replacement parts must be of similar design, construction and materials as the original parts. Replacement modules should have a current supplementary approval certificate. See General Certificate 6B/0 for special conditions for replacement of load cells covered by a cancelled certificate. Once repaired, the instrument must be verified or certified. The original nameplate must be retained or copied without alteration except for any change of supplementary number for the replaced module.

Instruments for which the certificate of approval has been cancelled, and which are removed from a site, may be relocated and used for trade provided they have not been altered (although they may be repaired or refurbished) and pass a verification or certification test.

8.9 Cancellation of an Application

An application may be cancelled if:

(a) a sample instrument or full documentation is not received within three months of acknowledgment of application; or

(b) an applicant fails to reply to an examination report within one month of its date of issue; or

(c) an applicant fails to rectify the non-compliance of the instrument within an additional two months from the reply to the examination report; or

(d) an applicant fails to reply to, or supply illustrations suitable for, the draft certificate and technical schedule within two months of the date of the covering letter to the draft.

An extension of time to the limits specified in (a), (b) and (c) will only be considered in extreme circumstances and on the individual merits of the application.

9. FEES PAYABLE

Fees are charged according to Regulation 90B and Schedule 13 of the Regulations.

If an applicant does not pay an account within thirty days of the date of invoice the following will apply until outstanding fees are paid:

(a) work which has stopped as a result of a failure will not resume;

(b) no certificate will be issued for any approval; and

(c) new applications will not be accepted.

5/6B/204A
21 April 2010

Australian Government
National Measurement Institute
Bradfield Road, West Lindfield NSW 2070

Notification of Change
Certificate of Approval No 5/6B/204A
Change No 1

Issued by the Chief Metrologist under Regulation 60
of the
National Measurement Regulations 1999

The following changes are made to the approval documentation for the

Liquid Controls Model M-40-1 Liquid-measuring System

submitted by Liquid Controls
105 Albrecht Drive
Lake Bluff IL 60044
USA.

A. In Certificate of Approval No 5/6B/204A dated 4 August 2005;

1. The Condition of Approval referring to the review of the approval should be amended to read:

   "This approval becomes subject to review on 1 January **2015**, and then every 5 years thereafter."

2. The FILING ADVICE should be amended by adding the following:

   "Notification of Change No 1 dated 21 April 2009

B. In Technical Schedule No 5/6B/204A dated 30 March 2005:

1. In clause **1.2 (iv) Gas Elimination Device**, the 1st paragraph should be amended to read, in part:

   "… model A8180 **or A8184A** air/vapour eliminator … "

2. In clause **2.1 Variant 1**, footnote (#1) to Table 1 should be amended to read, in part:

   "'A' designates the working pressure; may be … or blank (1034 kPa **or 1896 kPa for certain models)**."

3. In clause **2.2 Variant 2**, the 1st paragraph should be amended by deleting the text:

   "(excluding for aircraft refuelling)"

Signed by a person authorised by the Chief Metrologist to exercise his powers under Regulation 60 of the *National Measurement Regulations 1999*.

Australian Government

National Measurement Institute

12 Lyonpark Road, North Ryde NSW 2113

Certificate of Approval

No 5/6B/204A

Issued by the Chief Metrologist under Regulation 60
of the
National Measurement Regulations 1999

This is to certify that an approval for use for trade has been granted in respect of the

Liquid Controls Model M40 Liquid-measuring System

submitted by Liquid Controls
105 Albrecht Drive
Lake Bluff IL 60044-2242
USA.

NOTE: This Certificate relates to the suitability of the pattern of the instrument for use for trade only in respect of its metrological characteristics. This Certificate does not constitute or imply any guarantee of compliance by the manufacturer or any other person with any requirements regarding safety.

This Certificate is issued upon completion of a review of approval NSC 5/6B/204.

CONDITIONS OF APPROVAL

This approval becomes subject to review on 1 January 2010, and then every 5 years thereafter.

Instruments purporting to comply with this approval shall be marked with approval number 'NMI 5/6B/204A' and only by persons authorised by the submittor.

..../2

It is the submittor's responsibility to ensure that all instruments marked with this approval number are constructed as described in the documentation lodged with the National Measurement Institute (NMI) and with the relevant Certificate of Approval and Technical Schedule. Failure to comply with this Condition may attract penalties under Section 19B of the National Measurement Act and may result in cancellation or withdrawal of the approval, in accordance with document NMI P 106.

The National Measurement Institute reserves the right to examine any instrument or component of an instrument purporting to comply with this approval.

Auxiliary devices used with this instrument shall comply with the requirements of General Supplementary Certificate No S1/0/A.

DESCRIPTIVE ADVICE

Pattern: approved 17 December 2004

- A Liquid Controls model M40 liquid-measuring system.

Variants: approved 17 December 2004

1. Using certain other Liquid Controls meters as listed in Table 1.
2. As a mobile liquid-measuring system.
3. As a drum-filling liquid-measuring system.

Technical Schedule No 5/6B/204A describes the pattern and variants 1 to 3.

FILING ADVICE

The documentation for this approval comprises:

Certificate of Approval No 5/6B/204A dated 30 March 2005
Technical Schedule No 5/6B/204A dated 30 March 2005 (incl. Table 1 & Test Procedure)
Figures 1 to 5 dated 30 March 2005

Signed by a person authorised by the Chief Metrologist to exercise his powers under Regulation 60 of the National Measurement Regulations 1999.

TECHNICAL SCHEDULE No 5/6B/204A

Pattern: Liquid Controls Model M40 Liquid-measuring System

Submittor: Liquid Controls
105 Albrecht Drive
Lake Bluff IL 60044-2242
USA

1. Description of Pattern

A bulk-flowmetering system incorporating a Liquid Controls model M40 rotary motion positive displacement flowmeter (Table 1) for bulk metering of petroleum products other than LPG.

1.1 Field of Operation

The field of operation of the measuring system is determined by the following characteristics:

• Minimum measured quantity, V_{min}	200 L	(#1)
• Maximum flow rate, Q_{max}	1700 L/min	
• Minimum flow rate, Q_{min}	170 L/min	
• Maximum pressure of the liquid, P_{min}	1034 kPa	
• Minimum pressure of the liquid, P_{min}	140 kPa	(#2)
• Dynamic viscosity at 20°C	0.4 to 20 mPa.s	(#3)
• Liquid temperature range	-10 to 50°C	
• Ambient temperature range	-25 to 55°C	
• Accuracy class	0.5	

(#1) The calculator/indicator indicates the volume at least in 1 L increments.

(#2) As specified for the gas elimination device for effective operation.

(#3) The flowmeter is adjusted to be correct for the liquid for which it is to be verified/ certified as marked on the data plate.

1.2 Components of the Flowmetering System (Figure 1)

(i) Tank

A supply tank, which may incorporate a detector for low liquid-level. The detector is used to prevent further deliveries when the low liquid-level is reached, and prevents air from entering the pipework.

(ii) Pump

A positive displacement, centrifugal or submersible turbine type pump may be used to provide flow through one or more flowmeters.

Systems fitted with a positive displacement pump shall include a gas elimination device capable of continuously separating any air/vapours entrained in the liquid upstream of the flowmeter.

..../2

A centrifugal type pump may only be installed below the liquid level of the supply tank and a submersible turbine type pump may be used either alone or supplying a centrifugal type pump positioned above or below the liquid level of the supply tank. These systems shall include a gas elimination device capable of removing any pockets of air/vapours that may form in the pipework upstream of the flowmeter.

In any case, for all combination of usage, the pump(s) shall be of sufficient capacity to ensure that each flowmeter can operate over its approved flow rate range.

(iii) Non-return Valve

A non-return valve is fitted between the pump and the flowmeter to prevent reverse flow and keep the pipework full of liquid at all times.

(iv) Gas Elimination Device

The gas elimination device, comprising a Liquid Controls model F-30 strainer fitted with a model A8180 air/vapour eliminator (or any other equivalent approved gas elimination device), fitted upstream of the flowmeter to prevent vapours entering the flowmeter.

For applications where the duration of the shut down period does not cause thermal contraction of the liquid and formation of pockets of gas upstream of the flowmeter, the gas elimination device may be modified for use as a strainer only, provided the supply tank incorporates a detector for low liquid-level.

(v) Measurement Transducer

The measurement transducer is a Liquid Controls model M-40-1 rotary motion positive displacement flowmeter (Figure 2) with a mechanical output shaft connected via 90° bevel gear to a micrometer type calibration adjustment mechanism with a slotted shaft into which the drive shaft of the calculator/indicator fits.

The calibrator has a thimble which can be rotated in the direction marked for increasing or decreasing the rotation rate of the drive shaft of the calculator/indicator. The amount by which the volume, displayed by the calculator/indicator, is increased or decreased is determined with reference to the scale divisions on the calibrator, marked 1%, 0.1% and 0.02%.

The measurement transducer is suitable for accuracy Class 0.3.

The calibration adjustment is carried out using the liquid the flowmeter is intended to measure.

Provision is made for inserting a thermometer and fitting a pressure gauge for measuring the liquid temperature and pressure at the flowmeter during calibration.

(vi) Calculator/Indicator

The calculator/indicator is an approved Veeder-Root mechanical register, as described in the documentation of approval S184B. The drive shaft of the calculator/indicator is designed to fit the slotted shaft of the flowmeter calibration mechanism.

To facilitate the deliveries, a pre-set mechanism may be fitted between the mechanical calculator/indicator and the flowmeter provided the pre-set device is marked "Pre-set Amount Not for Trade Use" or similar wording. The pre-set device is mechanically linked to a Liquid Controls model V-7 flow control valve to automatically stop the delivery. Upon completion of delivery, the volume delivered is displayed by the calculator/indicator, which may differ from the pre-set amount.

The Veeder-Root mechanical register and the pre-set device may be replaced with any other compatible approved calculator/indicator and pre-set device.

(vii) Transfer Device

The transfer device is located downstream of the flowmeter and clearly defines the start and stop of the measured quantity. The transfer device may be in the form of a breakaway coupling, a nozzle or a positive shut-off component, such as a manually or automatically-operated flow control valve. Whatever the transfer device used, the pipework upstream of the transfer device shall be maintained full of liquid.

The system may have more than one transfer point, however the pipework design is such that once the measurement starts the flow continues through the intended transfer point until delivery is finalised; there is no possibility for diverting the measured quantity other than through the intended transfer point.

1.3 Descriptive Markings and Notices

Each measuring system shall bear the following information, placed together either on the indicating device or on a data plate:

Pattern approval mark	NMI 5/6B/204A	
Manufacturer's identification mark or trade mark	…..	
Meter model	…..	
Serial number of the instrument	…..	
Year of manufacture	…..	
Maximum flow rate, Q_{max}	….. L/min	
Minimum flow rate, Q_{min}	….. L/min	
Maximum pressure of the liquid, P_{max}	….. kPa	
Minimum pressure of the liquid, P_{min}	….. kPa	
Type of the liquid for which the system is verified	.....	(#)
Environmental class	class C	

(#) This may be located separately, e.g. on a metal tag sealed to the instrument.

The minimum measured quantity (V_{min}) is clearly visible on the indicating device, e.g. "Minimum Delivery 200 L".

1.4 Verification/Certification Provision

Provision is made for the application of a verification/certification mark.

1.5 Sealing Provision

Provision is made for sealing access to the calibration mechanism.

2. Description of Variants

2.1 Variant 1

Using certain other Liquid Controls flowmeters as listed in Table 1. Figure 3 shows a typical MS flowmeter.

TABLE 1

Flowmeter Model (#1)	Gas Eliminator Model (strainer with eliminator)	Maximum Flow (Q_{max}) (L/min)	Minimum Flow (Q_{min}) (L/min)	Minimum Delivery (L)
M-5	F-7 with A8180	227	22	20
M-7	F-7 with A8180	380	38	50
M-10	F-7 with A8180	570	57	100
M-15	F-15 with A8180	760	76	100
M-25	F-15 with A8180	1140	114	200
M-30	F-30 with A8180	1320	132	200
M-40	F-30 with A8180	1700	170	200
M-60	F-30 with A8180	2270	227	500
M-80	F-30 with A8180	3028	303	500
MS-7	FS-2” with A8930	380	38	50
MS-10	FS-2” with A8930	570	57	100
MS-15	FS-3” with A8930	760	76	100
MS-25	FS-3” with A8930	1140	114	200
MS-30	FS-3” or FS-4” with A8930	1320	132	200
MS-40	FS-4” with A8930	1700	170	200
MS-75	FS-4” or FS-6” with A8930	2650	265	500
MS-120 (150 mm)	FS-6” with A8930	3790	379	500
MS-120 (200 mm)	A8950	4540	454	500

For minimum deliveries less than 200 L the calculator/indicator displays the volume at least in increments of 0.1L. For minimum deliveries equal to or greater than 200 L the calculator/indicator displays the volume in 1 L increments.

For flowmeter sizes M5 to M25, the model A8180 gas elimination device may be replaced with the model A8197 device, which is similar to the A8180 except it incorporates a guide rod for the float

The A8950 series air/vapour eliminator, available in 3”, 4”, 6” or 8”size, may replace the equivalent strainer and air/vapour eliminator combination listed in Table 1.

The F-7 and F-15 strainers are replaced with F-7 (Hi-Cap) and F-15 (Hi-Cap) strainers for flowmetering systems where the supply tank can run dry.

..../5

(#1) Note that the flowmeter models listed above are basic model numbers only – the full model number may have additional alphanumeric characters, e.g. MSA-7-C-1, where:

'M' designates flowmeter.

'S' designates steel case, blank designates aluminium case.

'A' designates the working pressure; may be 'AA' (1896 kPa), 'A' (2413 kPa), 'B' (4964 kPa), 'C' (9928 kPa), or blank (1034 kPa).

'7' designates capacity, other capacities are listed in Table 1.

'C' designates flowmeter with counter, strainer and air eliminator, designation 'K' includes pre-set counter and pre-set valve.

'1' designates for use on refined petroleum products, or '2' for use on aviation and jet fuel.

2.2 Variant 2

As a mobile liquid-measuring system ~~(excluding for aircraft refuelling)~~ as shown in Figure 4, which is similar to the pattern except:

- The outlet of the flowmeter is fitted with a K-series air-activated check valve designed to stop the flow of liquid when air is detected by the air elimination device. Alternatively, the gas elimination device incorporates a high capacity stainer, either model F-7 (Hi-cap) or the model F-15 (Hi-cap) suitable for the 50 mm (2") flowmeters or the 75 mm (3") flowmeters respectively.
- A spring-loaded check valve is fitted between the gas elimination device and the flowmeter.
- The transfer device may be in the form of a nozzle at the end of a hose reel, in which case an anti-drain valve is fitted, that retains a pressure not less than 55 kPa, so that the pipework is maintained full of liquid up to the transfer point.

2.3 Variant 3

A drum-filling liquid-measuring system (Figure 5) which is similar to the pattern except:

- The flowmeter is fitted with a pre-set device adjusted to deliver a verified/certified fixed quantity, which is equal to or greater than the minimum delivery specified for the flowmeter, and set to deliver at nominal flow rate. For systems with variable flow rate, the pre-set quantity is equal to or greater than twice the minimum delivery specified for the flowmeter.
- The pre-set device is mechanically linked to a control valve, either a V or VS series mechanically-activated piston valve, installed at the outlet of the flowmeter to automatically stop the delivery when the pre-set quantity is reached.

- The volume indicator is replaced with a fixed marking stating the batch quantity for which the flowmetering system is set, e.g. “PRE-SET FOR 200 L”.
- The outlet is either a drum-filling spear or a hose. If a spear is used, it is arranged to fully drain after each delivery so that the control valve is the transfer device. If a hose is used, it is fitted with a nozzle which has an anti-drain valve that retains a pressure not less than 55 kPa, so that the hose upstream of the nozzle is maintained full of liquid and the nozzle is the transfer device.

TEST PROCEDURE

Instruments should be tested in accordance any relevant tests specified in the NSC Test Procedure No 13, *Non-driveway Flowmeters* using the type of liquid with which they will be used and which is marked on the instrument. Tests should be conducted in conjunction with any tests specified in the approval documentation for any indicator/ controller and/or any conversion device, etc. used.

Maximum Permissible Errors

For accuracy class 0.5:

The maximum permissible errors are:

±0.3% for calibration adjustment of the meter; and

±0.5% for in service tolerance of the measuring system.

It is forbidden to adjust the calibration of the meter to an error other than as close as practical to zero error.

The meter is required to be verified/certified with the liquid that the meter is metering.

Elimination of Air or Gas

The maximum permissible errors applicable for the elimination of air or gas are:

±0.5% for liquids having a dynamic viscosity not exceeding 1 mPa.s (e.g. petrol); and

±1.0% for liquids having a dynamic viscosity exceeding 1 mPa.s (e.g kerosene).

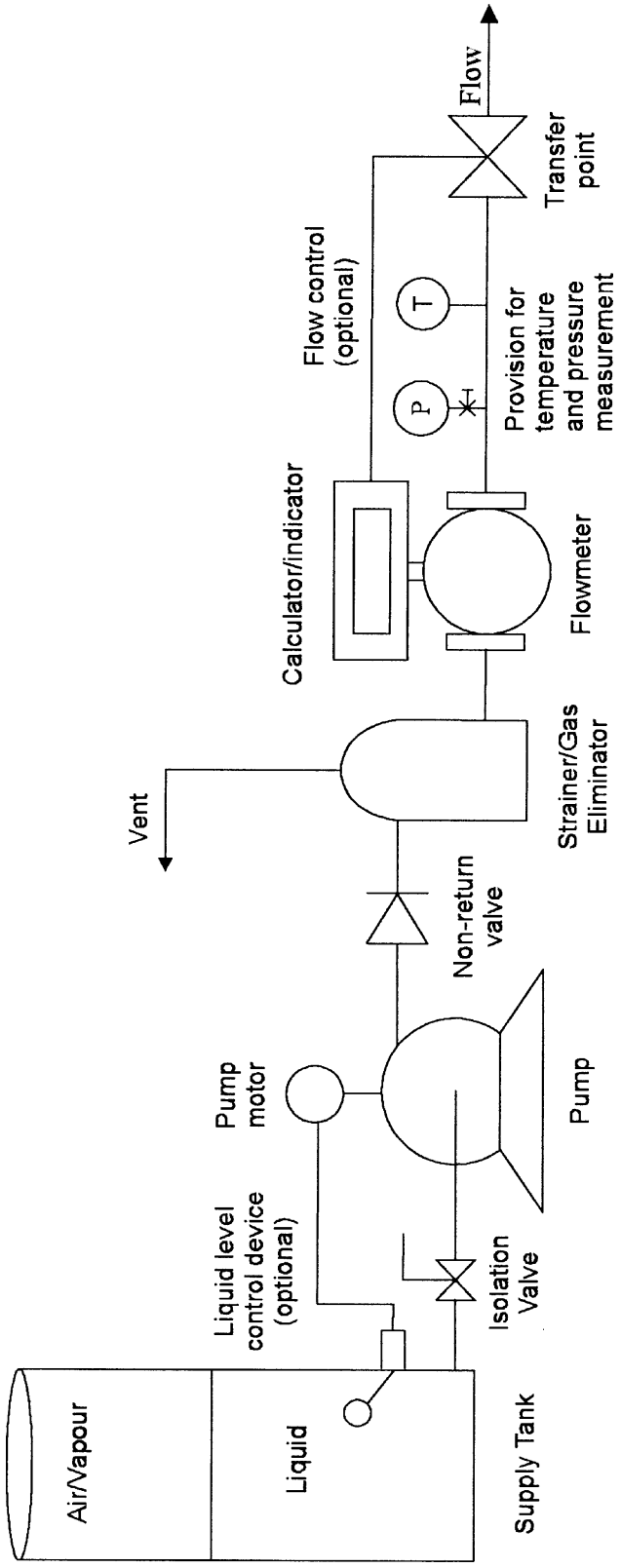
Hose Dilation Test

The maximum permissible errors applicable for hose dilation are:

±(0.01 x Minimum Measured Quantity) litres for systems without a hose reel; and

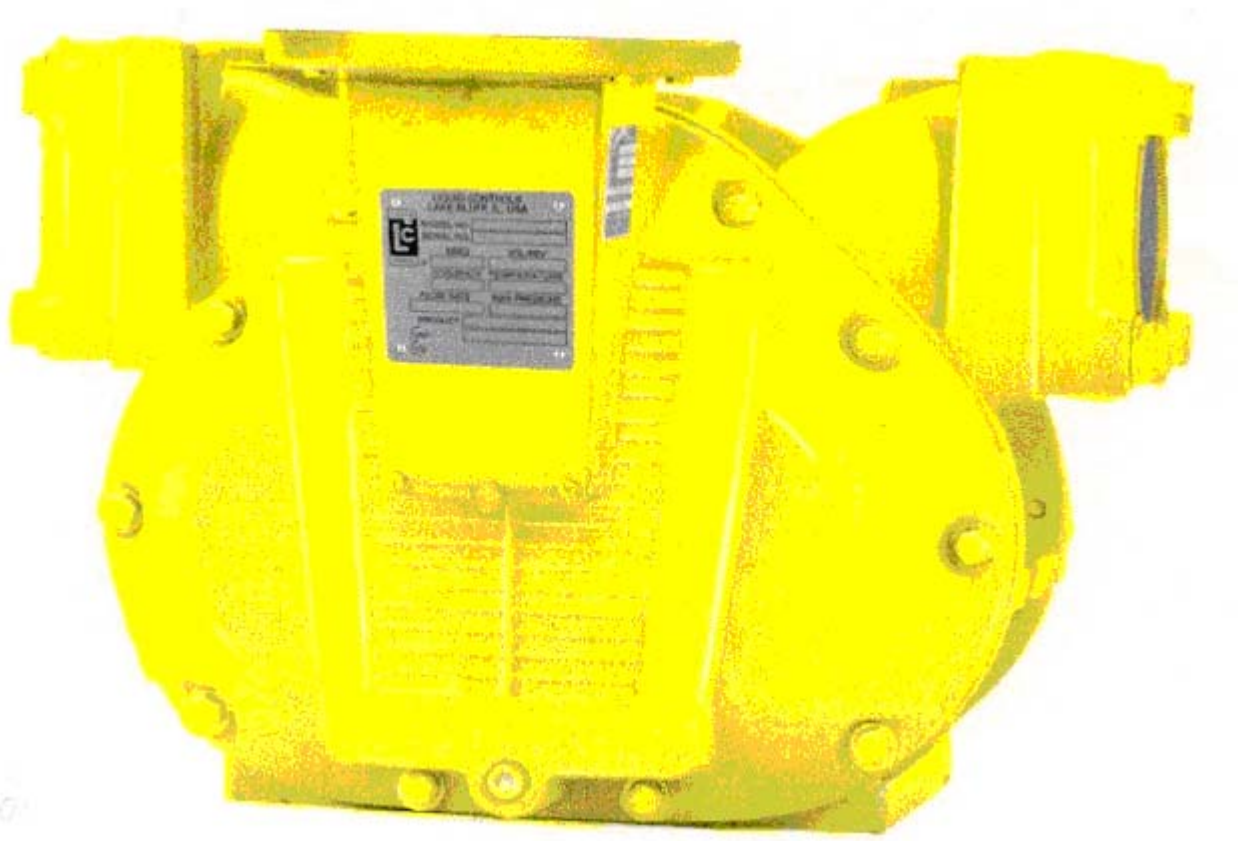
±(0.02 x Minimum Measured Quantity) litres for systems with a hose reel.

FIGURE 5/6B/204A – 1



Typical Liquid Controls Liquid-measuring System

FIGURE 5/6B/204A – 2

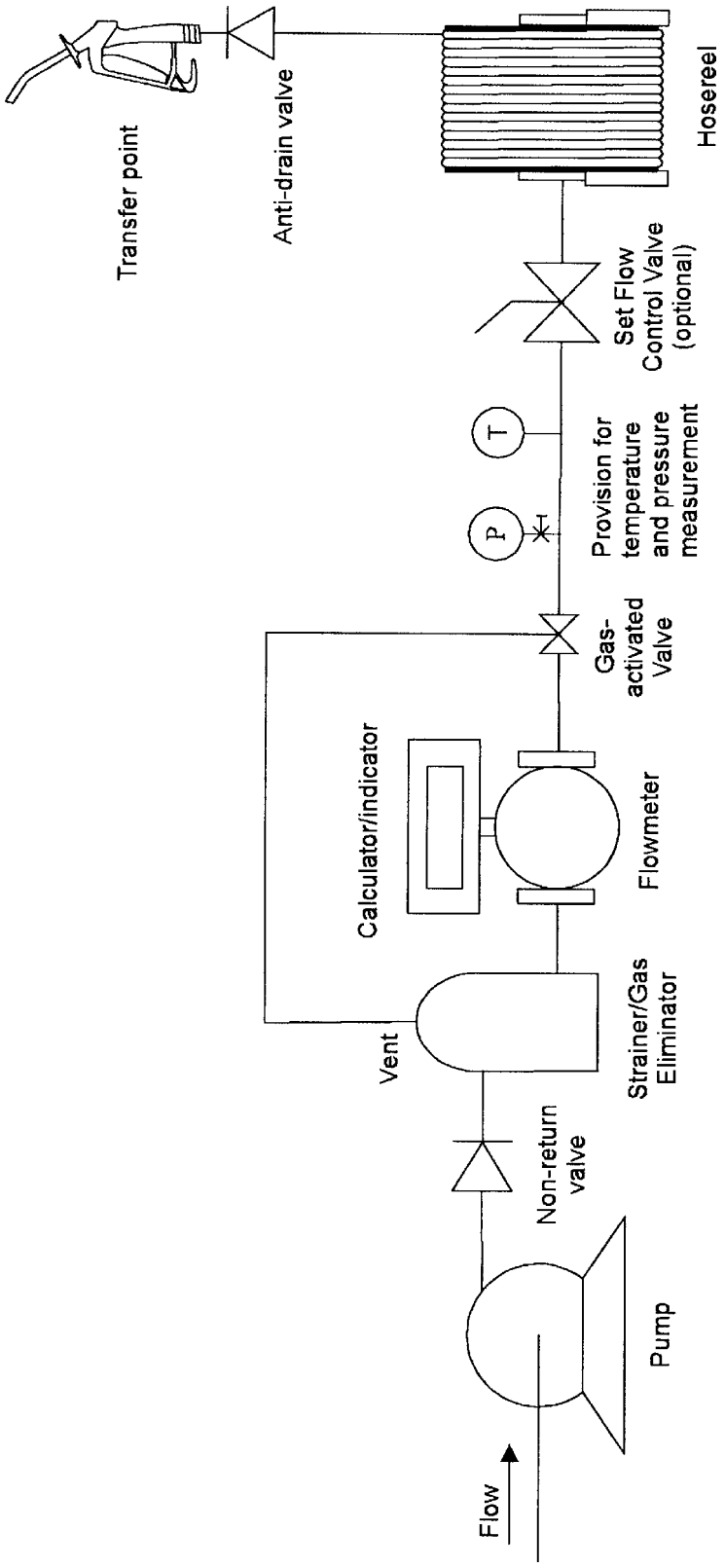


Liquid Controls Model M40 Flowmeter

FIGURE 5/6B/204A – 3

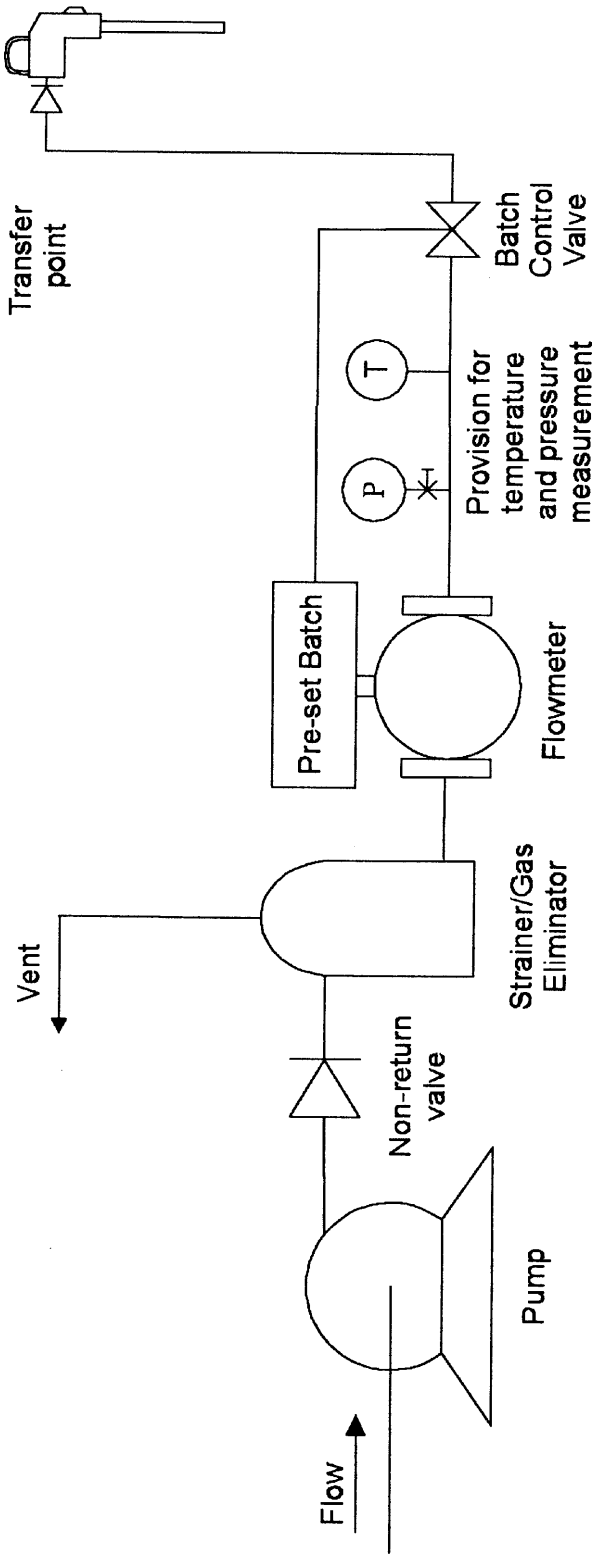
Liquid Controls Model MS Flowmeter

FIGURE 5/6B/204A – 4



Typical Liquid Controls Mobile Liquid-measuring System

FIGURE 5/6B/204A – 5



Typical Liquid Controls Drum-filling Liquid-measuring System

LIQUIP INTERNATIONAL PTY LTD - ENGINEERING DEPARTMENT - 13 HUME RD SMITHFIELD SYDNEY NSW AUSTRALIA 2164
PH: +61 2 9725 9000 FAX: +61 2 9609 4739 EMAIL: engineering@liquip-nsw.com.au

TECH TALK 0090
CHECK LIST FOR SPECIFYING A METERING SYSTEM (Including Diptronic)
12/05/10

METER/INDICATOR/ACCESSORIES CHECK LIST

CUSTOMER DETAILS

CUSTOMER INPUT

COUNTRIES	.....	
USEAGE	Truck. Gantry. Pipeline. Aviation. Drumfill.	
PRODUCTS	Liquid petroleum. Lube Oil. LPG. Blends. Chemicals	
FLOW RATE	Min	Max
PRESSURE	Min	Max
AMBIENT TEMP	Min	Max
LIQUID TEMP	Min	Max
VISCOSITY	.....	@ .....°C
MINIUM DELIVERY VOLUME	.....Litres	

ACCURACY APPROVALS REQUIRED?

Australia & NZ	OIML R117
Europe & UK	OIML R117
USA Majority	NTEP to Handbook 44
USA Few States	Individual Certs. Required
USA Minnesota	Special Temp Comp Tables
Canada	SVM-1

SAFETY APPROVALS REQUIRED?

For what Zone?	0, 1 or 2? (or Division 1 or 2?)
Australia & NZ	IEC
Europe & UK	IEC & ATEX
USA	“Division” System via FM
Canada	Canadian Division system via FM

PERFORMANCE REQUIRED

Accuracy Required
Max Allowable Pressure Drop
Budget Limitation? Max Cost
Totalisor only? Or Preset?

PIPELINE & MATERIALS

Pipe Size Inlet
Pipe Size Outlet
Pipe Material
Location of Meter in Pipeline
Meter Mounting Method
Meter Orientation

Australian Government
National Measurement Institute

NMI R 117-1

Measuring Systems for Liquids Other than Water

(OIML R 117-1:1995(E), MOD)

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PREFACE

NMI R 117-1 specifies the mandatory metrological and technical requirements for the pattern approval of measuring systems for liquids other than water. It is a modified version of OIML R 117-1:1992, *Measuring Systems for Liquids other than Water* published by the International Organisation of Legal Metrology (OIML).

NMI R 117-1 differs in some details from OIML R 117 and the differences are underlined. These differences give requirements specific to Australia and therefore were not included in the international recommendation.

Several references are made to other OIML and international publications. Where there is an Australian equivalent, reference is made to both documents, otherwise only the international document is referenced.

INTERPRETATION

NMI has decided to allow a reduced environmental temperature range requirement for volume measuring instruments that is more practical for Australian outdoor applications.

Although approval to OIML requirements as defined in NMI R 117-1 is –25°C to 55°C (i.e. class C), we are now allowing (on request) the approval of volume measuring instruments exclusively for use in Australia over a temperature range of –10°C to 55°C. This environment classification is class N (where N stands for national).

CONTENTS

TERMINOLOGY

The terminology used in this document conforms to the *International Vocabulary of Basic and General Terms in Metrology* (VIM — 1993 edition) and the *Vocabulary of Legal Metrology* (VML — 1978 edition). In addition, for the purposes of this Recommendation, the following definitions apply.

Notes:

(1) This terminology must be considered as a part of this document.

(2) The following terminology is classified from a functional point of view. Annex C gives classifications by alphabetic order and by theme.

T.1 Measuring System and its Constituents

T.1.1 Meter for volumes of liquids

An instrument intended to measure continuously, memorise and display the volume of liquid passing through the measurement transducer at metering conditions.

Note: A meter includes at least a measurement transducer, a calculator (including adjustment or correction devices if present) and an indicating device.

T.1.2 Measurement transducer

A part of the meter which transforms the flow or the volume of the liquid to be measured into signals which are passed to the calculator. It may be autonomous or use an external power source.

Note: For the purposes of this document, the measurement transducer includes the flow or volume sensor.

T.1.3 Calculator

A 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. In addition, the calculator may be capable of communicating both ways with peripheral equipment.

T.1.4 Indicating device

A 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.

T.1.5 Ancillary device

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

Main ancillary devices are:

- zero setting device;
- repeating indicating device;
- printing device;
- memory device,
- price indicating device;
- totalising indicating device;
- conversion device;
- pre-setting device; and
- self-service device.

Note: An ancillary device may or may not be subject to legal metrology control according to its function in the measuring system.

T.1.6 Additional device

A 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.

Main additional devices are:

- gas elimination device;
- gas indicator;
- sight glass;
- filter, pump;
- device used for the transfer point;
- anti-swirl device;
- branches or bypasses; and
- valves, hoses.

T.1.7 Measuring system

A system which comprises the meter itself and all the ancillary devices and additional devices.

T.1.8 Pre-setting device

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

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

T.1.9 Adjustment device

A 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.

T.1.10 Associated measuring instruments

Instruments connected to the calculator, the correction device or the conversion device, for measuring certain quantities which are characteristic of the liquid, with a view to making a correction and/or a conversion.

T.1.11 Correction device

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

The characteristics of the liquid may either be measured using associated measuring instruments, or stored in a memory in the instrument.

T.1.12 Conversion device

A device which automatically converts the volume measured at metering conditions into a volume at base conditions, or into a mass, by taking account of the characteristics of the liquid (temperature, pressure, density, relative density...) measured using associated measuring instruments, or stored in a memory.

The quotient of the volume at base conditions, or of the mass, to the volume at metering conditions is referred to as 'conversion factor'.

T.1.13 Metering conditions

The conditions of the liquid of which the volume is to be measured, at the point of measurement (example: temperature and pressure of the measured liquid).

T.1.14 Base conditions

The specified conditions to which the measured volume of liquid is converted (example: base temperature and base pressure).

Notes:

(1) Metering and base conditions (which refer only to the volume of liquid to be measured or indicated) should not be confused with the 'rated operating conditions' and 'reference conditions' which apply to influence quantities.

(2) The values chosen as base conditions are 15°C and 101 325 Pa.

T.1.15 Transfer point

A point at which the liquid is defined as being delivered or received.

T.1.16 Gas separator

A device used for continuously separating, and removing, any air or gases contained in the liquid.

Note: In general, devices defined from T.1.16 to T.1.19 are called gas elimination devices.

T.1.17 Gas extractor

A device used to extract air or gases accumulated in the supply line of the meter in the form of pockets that are no more than slightly mixed with the liquid.

T.1.18 Special gas extractor

A device which, like the gas separator but under less stringent operating conditions, continuously separates any air or gases contained in the liquid, and which automatically stops the flow of liquid if there is a risk of air or gases, accumulated in the form of pockets no more than slightly mixed with the liquid, entering the meter.

T.1.19 Condenser tank

In pressurised liquefied gas measuring systems, a closed tank used to collect the gases contained in the liquid to be measured and to condense them before measuring.

T.1.20 Gas indicator

A device allowing easy detection of any air or gas bubbles which may be present in the liquid flow.

T.1.21 Sight glass

A device for checking, before start-up and after shut-down, that all or part of the measuring system is filled completely with liquid.

T.2 Specific Types of Measuring Systems

T.2.1 Fuel dispenser

A measuring system intended for the refuelling of motor vehicles, small boats and small aircraft.

T.2.2 Measuring system on a pipeline

A measuring system which in principle is installed on a fixed pipeline connecting two or more fixed tanks.

Note: This pipeline is characterised by a flow rate of the liquid to be measured which, in general, either does not change or changes little during a prolonged period.

T.2.3 Aircraft refuelling tanker measuring system

A tanker mounted measuring system intended for refuelling aircraft, supplied from a tank mounted on the vehicle.

T.2.4 Aircraft hydrant measuring system

A mobile measuring system intended for refuelling aircraft, supplied from hydrant pits.

T.2.5 Blend dispenser

A fuel dispenser providing mixtures of various grades of petrol (multigrade-dispenser) or mixtures of petrol and lubricating oil (petrol-oil-dispenser) through a single nozzle.

T.2.6 Self-service arrangement

An arrangement that allows the customer to use a measuring system for the purpose of obtaining liquid for his own purchase.

T.2.7 Self-service device

A 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.

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

T.2.8 Attended service mode

An operating mode of a self-service arrangement in which the supplier is present and controls the authorisation 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.

(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.

T.2.9 Unattended service mode

An operating mode of a self-service arrangement in which the self-service arrangement controls the authorisation 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 memorising) of information concerning the measurement operation.

T.2.10 Pre-payment

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

T.2.11 Attended post-payment (or post-payment)

A 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.

T.2.12 Unattended post-payment (or delayed payment)

A 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.

T.2.13 Authorisation of a measuring system

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

T.2.14 Direct selling to the public

A transaction (selling or buying) of quantities of liquids whose settlement is associated with indications provided by a measuring system, any of the parties having access to the place of measurement and one of them being a consumer.

Notes:

(1) The consumer can be any person. Generally the consumer is the buyer but s/he can also be the seller.

(2) Main measuring systems used for direct selling to the public are:
- fuel dispensers; and
- measuring systems on road tankers for the transport and delivery of domestic fuel oil.

T.3 Metrological Characteristics

T.3.1 Primary indication

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

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

T.3.2 Absolute error of measurement

The result of a measurement minus the (conventional) true value of the measurand (adapted from VIM 3.10).

T.3.3 Relative error

The absolute error of measurement divided by the (conventional) true value of the measurand (adapted from VIM 3.12).

T.3.4 Maximum permissible errors

The extreme values permitted by the present document for an error.

Notes:

(1) In this text, maximum permissible errors are stated, according to the case, as relative errors (general case) or absolute errors.

(2) To simplify writing, some specifications in the present text involve the comparison of a volume (for instance: difference between a result obtained at some specified conditions and a result obtained at reference conditions) with maximum permissible error. In this case, it is obvious that it is the absolute maximum permissible error, associated with the relative maximum permissible error, which applies.

T.3.5 Minimum measured quantity of a measuring system

The smallest volume of liquid for which the measurement is metrologically acceptable for that system.

Note: In measuring systems intended to deliver, this smallest volume is referred to as the minimum delivery; in those intended for receiving operations, it is referred to as the minimum receipt.

T.3.6 Minimum specified volume deviation

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

T.3.7 Minimum specified price deviation

The price to pay corresponding to the minimum specified volume deviation.

T.3.8 Repeatability error

For the purposes of this document, the difference between the largest and the smallest results of successive measurements of the same quantity carried out under the same conditions.

T.3.9 Intrinsic error

The error of a measuring system used under reference conditions.

T.3.10 Initial intrinsic error

The intrinsic error of a measuring system as determined prior to all performance tests.

T.3.11 Fault(*)

The difference between the error of indication and the intrinsic error of a measuring system.

T.3.12 Significant fault(*)

A fault the magnitude of which is greater than the larger of these two values:

- one-fifth of the magnitude of the maximum permissible error for the measured volume; and
- the minimum specified volume deviation.

The following are not considered to be significant faults:

(*) Definitions of terms marked with (*) are relevant to electronic measuring systems only.

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

T.3.13 Durability(*)

The capability of the measuring system to keep its performance characteristics over a period of use.

T.3.14 Interruptible/non-interruptible measuring system

A measuring system is considered as interruptible/non-interruptible when the liquid flow can/cannot be stopped easily and rapidly.

T.3.15 Cyclic volume

The volume of liquid corresponding to the working cycle of the measurement transducer, i.e. the sequence of movements at the end of which all the internal moving parts of this transducer return, for the first time, to their initial positions.

T.3.16 Periodic variation

The maximum difference, during one working cycle, between the volume produced by the displacement of the measuring parts and the corresponding volume as shown by the indicating device, the latter being connected without play or slip to the measuring device and in such a way that it indicates at the end of the cycle, and for this cycle, a volume equal to the cyclic volume; this variation may be reduced in some cases by the incorporation of a suitable correction device.

Note: The effect of the correction device is included when the periodic variation is determined.

T.3.17 First element of an indicating device

Element which, in an indicating device comprising several elements, carries the graduated scale with the smallest scale interval.

T.4 Test conditions

T.4.1 Influence quantity

A quantity which is not the subject of the measurement but which influences the value of the measurand or the indication of the measuring system (adapted from VIM 2.7).

T.4.2 Influence factor(*)

An influence quantity having a value within the rated operating conditions of the measuring system, as specified in this document.

(*) See note to T.3.11.

T.4.3 Disturbance(*)

An influence quantity having a value within the limits specified hereafter in this document, but outside the specified rated operating conditions of the measuring system.

Note: An influence quantity is a disturbance if for that influence quantity the rated operating conditions are not specified.

T.4.4 Rated operating conditions(*)

Conditions of use, giving the range of values of influence quantities for which the metrological characteristics are intended to be within the maximum permissible errors.

T.4.5 Reference conditions

A set of specified values of influence factors fixed to ensure valid intercomparison of results of measurements (adapted from VIM 5.7).

T.4.6 Performance test

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

T.4.7 Endurance test

A test intended to verify whether the meter or the measuring system is able to maintain its performance characteristics over a period of use.

T.4.8 Uncertainty of the determination of an error

An estimate characterising the range of values within which the true value of an error lies, including components due to the standard and its use, and components due to the verified or calibrated instrument itself.

Note: Components due to a verified or calibrated meter are notably linked to the resolution of its indicating device and to the periodic variation.

T.5 Electronic or electrical equipment

T.5.1 Electronic device

A device employing electronic sub-assemblies and performing a specific function. Electronic devices are usually manufactured as separate units and are capable of being tested independently.

Note: Electronic devices, as defined above, may be complete measuring systems or part of measuring systems, in particular such as those mentioned in T.1.1 through T.1.5.

T.5.2 Electronic sub-assembly

A part of an electronic device, employing electronic components and having a recognisable function of its own.

T.5.3 Electronic component

The smallest physical entity which uses electron or hole conduction in semi-conductors, gases, or in a vacuum.

T.5.4 Checking facility

A facility which is incorporated in a measuring system and which enables significant faults to be detected and acted upon.

Note: The checking of a transmission device aims at verifying that all the information which is transmitted (and only that information) is fully received by the receiving equipment.

T.5.5 Automatic checking facility

A checking facility operating without the intervention of an operator.

T.5.6 Permanent automatic checking facility (type P)

An automatic checking facility operating during the entire measurement operation.

T.5.7 Intermittent automatic checking facility (type I)

An automatic checking facility operating at least once, either at the beginning or at the end of each measurement operation.

T.5.8 Non-automatic checking facility (type N)

A checking facility which requires the intervention of an operator.

T.5.9 Power supply device

A device which provides the electronic devices with the required electrical energy, using one or several sources of a.c. or d.c.

1. FIELD OF APPLICATION

1.1 Scope

This document specifies the metrological and technical requirements applicable to dynamic measuring systems for quantities of liquids other than water subject to legal metrology controls. It provides requirements for the pattern approval of measuring systems as well as supplementary approvals of parts of the measuring systems (meter, etc.).

In principle, this document applies to all measuring systems fitted with a meter as defined in T.1.1 (continuous measurement), whatever be the measuring principle of the meters or their application, except direct mass measuring systems (see NMI R 105).

This document applies to systems in which volume measurements are converted to mass indication.

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

1.2 Liquids to be Measured

Measuring systems that are covered by this document may be used for the following liquids:

- liquid petroleum and related products: crude oil, liquid hydrocarbons, liquefied petroleum gas (LPG), liquid fuel, lubricants, industrial oils, etc. (see e.g. ISO 1998-1, 1998-2, 6743-0, 8216-0);
- liquid food: dairy products (milk, cream, etc.), beer and brewer's wort, wine and musts (cider, etc.), alcoholic beverages (liquor, whisky, etc.) non-alcoholic carbonated and not carbonated beverages, juices and concentrates, vegetable oils (soya-bean-oil, palm-oil, etc.);
- alcohol: pure ethanol (ethyl alcohol) and mixtures of only ethanol and water;
- chemical products in liquid state: HCl, H_2SO_4, ammonia water etc.; and
- other liquids: all other liquids except cold potable water, hot water and water containing effluent; examples: distilled water and deionised water, liquids used for calibration of tanks.

2. GENERAL REQUIREMENTS

2.1 Constituents of a Measuring System

A meter itself is not a measuring system. The smallest possible measuring system includes:

- a meter;
- a transfer point; and
- a hydraulic circuit with particular characteristics which must be taken into account.

For correct operation, it is often necessary to add to this set:

- a gas elimination device,
- a filter device,
- a pumping device,
- correction devices related to temperature, viscosity, etc.

The measuring system may be provided with other ancillary and additional devices (see 2.2).

If several meters are intended for a single measuring operation, the meters are considered to form a single measuring system.

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

2.2 Ancillary Devices

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

As a rule these ancillary devices are optional. However, this document makes some of them mandatory, or prohibits some of them, for particular types of measuring systems.

In addition the following are mandatory:

- Primary indications shall remain accessible to the parties interested in a transaction up to the settlement of the transaction (see notes 2 and 3 of T.2.8).
- Self-service operation of a fuel dispenser requires that the following auxiliary devices be included in the transaction: the fuel dispenser indicator, a control console and a customer's indicator at the control console. A ticket printer for issuing a receipt is optional.
- Unattended operation of a fuel dispenser requires that the following auxiliary devices be included in the transaction: the fuel dispenser indicator, a control device and a ticket printer. The ticket printer need not automatically issue a ticket, but the ticket or other records must be available on demand by all parties involved in the transaction.
- For measuring systems (see clauses 5.4 and 5.7) dispensing LPG or other gases which can be liquefied by compression without refrigeration, a conversion device which converts the volume to volume at base conditions (see T.1.14) or to mass.

2.2.2 When these ancillary devices are mandatory in application of this document they are considered as integral parts of the measuring system, they are subject to control, and they shall meet the requirements of this document.

2.2.3 When ancillary devices are not subject to control, one shall verify that these devices do 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.

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.

2.3 Field of Operation

2.3.1 The field of operation of a measuring system is determined by the following characteristics:

- minimum measured quantity;
- measuring range limited by the minimum flow rate, Q_{min}, and the maximum flow rate, Q_{max};
- maximum pressure of the liquid, P_{max};
- minimum pressure of the liquid, P_{min};
- nature of the liquid(s) to be measured and the limits of kinematic or dynamic viscosity when an indication of the nature of the liquids alone is not sufficient to characterise their viscosity;
- maximum temperature of the liquid, T_{max};
- minimum temperature of the liquid, T_{min}; and
- environmental class (see A.2).

2.3.2 The minimum measured quantity of a measuring system shall have the form 1×10^n, 2×10^n or 5×10^n authorised units of volume, where n is a positive or negative whole number, or zero.

The minimum measured quantity shall satisfy the conditions of use of the measuring system; except in exceptional cases, the measuring system shall not be used for measuring quantities less than this minimum measured quantity.

The minimum measured quantity of a measuring system shall be not less than the largest minimum measured quantity of any one of its constituent elements (meter(s), gas extractor(s), special gas extractor(s), etc.). However, for gas elimination devices this provision does not need to be fulfilled if it is demonstrated (including tests) that it is not necessary.

2.3.3 The measuring range shall satisfy the conditions of use of the measuring system; the latter shall be designed so that the flow rate is between the minimum flow rate and the maximum flow rate, except at the beginning and at the end of the measurement or during interruptions.

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

Except in the case of specific provisions for certain types of measuring systems, the maximum flow rate of the measuring system shall normally be equal to at least four times the minimum flow rate of the meter or the sum of the minimum flow rates of the meters with which it is fitted. In some particular cases the ratio may be two.

2.3.4 A measuring system shall exclusively be used for measuring liquids having characteristics within its field of operation, as specified in the pattern approval certificate. The field of operation of a measuring system shall be within the fields of measurement of each of its constituent elements (meters, gas elimination devices).

When two or more meters are mounted in parallel in the same measuring system, the limiting flow rates (Q_{max}, Q_{min}) of the various meters are taken into consideration, especially the sum of the limiting flow rates, to verify if the measuring system meets the provision above.

2.4 Accuracy Classes

Taking into consideration their field of application, measuring systems are classified into five accuracy classes according to Table 1.

2.5 Maximum Permissible Errors

2.5.1 For volumes not smaller than 2 L, and without prejudice to 2.5.3, the maximum permissible relative errors, positive or negative, on volume indications are specified in Table 2.

2.5.2 For volumes smaller than 2 L, and without prejudice to 2.5.3, the maximum permissible errors, positive or negative, on volume indications are specified in Table 3.

Table 1

Class	Field of application
0.3	Measuring systems on pipeline (see 5.6)
0.5	All measuring systems if not differently stated elsewhere in this table, in particular: • fuel dispensers for motor vehicles (other than LPG dispensers) (see 5.1 and 5.9); • measuring systems on road tankers for liquids of low viscosity (see 5.2); • measuring systems for the unloading of ships' tanks and rail and road tankers (see 5.3); • measuring systems for milk (see 5.5); • measuring systems for loading ships (see 5.6); and • measuring systems for refuelling aircraft (see 5.8)
1.0	Measuring systems (other than LPG dispensers) for liquefied gases under pressure measured at a temperature equal to or above –10°C (see 5.4) LPG dispensers for motor vehicles (see 5.7) Measuring systems normally in class 0.3 or 0.5 but used for liquids: • whose temperature is less than –10°C or greater than 50°C; or • whose dynamic viscosity is higher than 1 000 mPa.s; or • whose maximum volumetric flow rate is not higher than 20 L/h
1.5	Measuring systems for liquefied carbon dioxide (see 5.4.10), Measuring systems (other than LPG dispensers) for liquefied gases under pressure measured at a temperature below –10°C (see 5.4)
2.5	Measuring systems for liquids at a temperature below –153°C

Table 2

	Accuracy classes				
	0.3	0.5	1.0	1.5	2.5
A (see 2.6)	0.3%	0.5%	1.0%	1.5%	2.5%
B (see 2.6)	0.2%	0.3%	0.6%	1.0%	1.5%

Table 3

Measured quantity	Maximum permissible errors
From 1 to 2 L	Value fixed in Table 2, applied to 2 L
From 0.4 to 1 L	Twice the value fixed in Table 2
0.2 to 0.4 L	Twice the value fixed in Table 2, applied to 0.4 L
From 0.1 to 0.2 L	Quadruple the value fixed in Table 2
Less than 0.1 L	Quadruple the value fixed in Table 2, applied to 0.1 L

2.5.3 However, whatever the measured quantity may be, the magnitude of the maximum permissible error is given by the greater of the following two values:

- absolute value of the maximum permissible error given in Table 2 or Table 3; and
- minimum specified volume deviation.

For minimum measured quantities greater than or equal to 2 L, the minimum specified volume deviation (E_{min}) is given by the formula:

$$E_{min} = (2\ V_{min}) \times (A/100)$$

where: V_{min} is the minimum measured quantity and A is the numerical value specified in line A of Table 2 for the relevant accuracy class.

For minimum measured quantities less than 2 L, the minimum specified volume deviation is twice the value specified in Table 3, and related to line A of Table 2.

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

2.6 Conditions for Applying Maximum Permissible Errors

Provisions in this clause apply to volume indications at metering conditions (see 2.7 for converted indications).

2.6.1 Maximum permissible errors in line A of Table 2 apply to complete measuring systems, for all liquids, all temperatures and all pressures of the liquids, and all flow rates for which the system is intended to be, or has been approved, without any adjustment between the various tests, for:

- pattern approval;
- initial verification in one stage or the second stage of a two-stage initial verification; and
- subsequent verifications.

2.6.2 Maximum permissible errors in line B of Table 2 apply to:

- pattern approval of a meter, for all liquids, all temperatures and all pressures of the liquids, and all flow rates for which the system is intended to be approved; and
- initial verification (first stage of the verification) of a meter intended to be fitted in a measuring system subject to a two-stage initial verification.

Notes:

(1) An adjustment is allowed for each liquid, but in this case the pattern approval certificate provides information on the capability of the meter to measure all the liquids without particular precautions. For example, the meter may be allowed only for measuring one liquid in normal use, or an automatic device that provides an adaptation to each liquid may be necessary.

(2) If the meter is provided with an adjustment or correction device, it is sufficient to verify that the error curve(s) is (are) within a range of two times the value specified in line B of Table 2.

(3) See example in 6.1.5.2.4.

2.6.3 When stated in the pattern approval certificate, a one-stage initial verification or the second stage of a two-stage initial verification of a measuring system intended to measure two or more liquids may be carried out with one liquid only or with a liquid different from the intended liquids. In this case and if necessary, the pattern approval certificate provides a smaller range or a shift for maximum permissible errors, so that 2.6.1 is fulfilled by the measuring system for all intended liquids.

When stated in the pattern approval certificate, the initial verification of a meter of a measuring system intended to measure two or more liquids may be carried out with one liquid only or with a liquid different from the intended liquids. In this case and if necessary, the pattern approval certificate provides a smaller range or a shift for maximum permissible errors, so that 2.6.2 is fulfilled by the meter for all intended liquids.

The above considerations may be extended to the case of a measuring system or a meter intended to measure only one liquid but verified with another liquid.

2.7 Provisions for Converted Indications

2.7.1 Maximum permissible errors on conversion devices

When a conversion device for converting into a volume at base conditions or into a mass (including all its components and associated measuring instruments) is verified separately, maximum permissible errors on converted indications due to the conversion device, positive or negative, are equal to ± (A – B), A and B being the values specified in Table 2. However, the magnitude of the maximum permissible error shall not be less than the greater of the two following values:

- one-half scale interval of the indicating device for converted indications; and
- half of the value corresponding to the minimum specified volume deviation.

2.7.2 Accuracy of associated measuring instruments

When verified separately, associated measuring instruments shall exhibit an accuracy at least as good as the values in Table 4.

These values apply to the indications of associated measuring instruments taken into account for the calculation of the converted quantity (they include errors mentioned in 2.7.3).

Table 4

Maximum permissible errors on measuring:	Accuracy classes of the measuring system				
	0.3	0.5	1.0	1.5	2.5
Temperature	±0.3°C	±0.5°C			±1°C
Pressure	less than 1 MPa: ±50 kPa between 1 and 4 MPa: ±5% more than 4 MPa: ±200 kPa				
Density	±1 kg/m^3		±2 kg/m^3		±5 kg/m^3

2.7.3 Accuracy for calculation of characteristic quantities of the liquid

When the calculating function of a conversion device is verified separately, the maximum permissible error for the calculation of each characteristic quantity of the liquid, positive or negative, is equal to two fifths of the value fixed in 2.7.2. However the magnitude of the maximum permissible error shall not be less than one-half scale interval of the indicating device for converted indications.

2.7.4 Direct verification of a converted mass indication

When a conversion device is only associated with (or included in) a meter and when the converted mass indication is verified directly by comparison to mass standards (e.g. by using a weighing machine) the maximum permissible errors (MPE) on the converted indication, positive or negative, are given by the formula:

$$\text{MPE} = \pm [\ B^2 + (A - B)^2\ ]^{1/2}$$

where *A* and *B* are the values specified in Table 2.

When a conversion device is included in a measuring system, maximum permissible errors of line A of Table 2 apply to the converted mass indication. However in any case, the magnitude of maximum permissible errors shall not be less than the mass corresponding to the minimum specified volume deviation.

2.7.5 Direct verification of a converted volume indication

Standards delivering directly the true value of converted volume indications are not available for general uses. Such standards only exist for a given liquid or for very similar liquids. When such standards are available, provisions in 2.7.4 can be applied by analogy.

2.8 Maximum Permissible Errors on Calculators

Maximum permissible errors on quantities of liquid indications applicable to calculators, positive or negative, when they are tested separately, are equal to one-tenth of the maximum permissible error defined in line A of Table 2. However, the magnitude of the maximum permissible error shall not be less than one half scale interval of the measuring system in which the calculator is intended to be included.

2.9 Indications

2.9.1 The volume indication shall be made in cubic centimetres or millilitres, in cubic decimetres or litres, in cubic metres or kilolitres, or megalitres. The symbol or the name of the unit shall appear in the immediate vicinity of the indication.

Mass may only be indicated in tonnes, kilograms or grams. The symbol or the name of the unit shall appear in the immediate vicinity of the indication.

2.9.2 Measuring systems shall be provided with an indicating device giving the volume of liquid measured at metering conditions.

Without prejudice to the provisions in 2.9.3, when a measuring system is fitted with a conversion device, it shall be fitted (in addition to the device indicating volumes at metering conditions) with a device indicating the volume at base conditions or the mass.

Provisions applicable to devices which indicate the volume at metering conditions apply to devices which indicate the volume at base conditions and by analogy to devices which indicate the mass.

2.9.3 The use of the same display for the indications of volume at metering conditions and of volume at base conditions or of mass is authorised provided that the nature of the displayed quantity is clear and that these indications are available on request.

2.9.4 A measuring system may have several devices indicating the same quantity. Each shall meet the requirements of this document. The scale intervals of the various indications may be different.

2.9.5 For any measured quantity relating to the same measurement, the indications provided by various devices shall not deviate one from another by more than one scale interval or the greatest of the two scale intervals if they differ, except otherwise provided in 5 (see 5.10.1.3).

2.9.6 Subject to specific provisions for certain types of measuring systems, use of the same indicating device for the indications of several measuring systems (which then have a common indicating device) is authorised provided that one of the following conditions is met:

- it is impossible to use any two of these measuring systems simultaneously,
- the indications relating to a given measuring system are accompanied by a clear identification of that measuring system and the user may obtain the indication corresponding to any of the measuring systems concerned, using a simple command.

2.10 Elimination of Air or Gases

2.10.1 General requirements

Measuring systems shall be constructed and installed so that during normal operation, neither air intake nor gas release will occur in the liquid upstream of the meter. If there is a risk that this requirement may not be met, the measuring systems shall incorporate a gas elimination device permitting the proper elimination of any air or undissolved gases which may be contained in the liquid before it enters the meter.

The gas elimination device shall be suitable for the supply conditions and be arranged in such a way that the effect due to the influence of the air or gases on the measuring result does not exceed:

(a) 0.5% of the quantity measured for liquids other than potable liquids and for liquids of a viscosity not exceeding 1 mPa.s;

(b) 1% of the quantity measured for potable liquids and for liquids of a viscosity exceeding 1 mPa.s.

However, it is not necessary for this effect to be less than 1% of the minimum measured quantity.

The values specified in this paragraph apply to the gas elimination device when it is subject to separate control, e.g. for pattern approval.

In this case, they apply to the differences between:

- the meter errors with air intake or with gas; and
- the meter errors without air intake or gas.

2.10.2 Pumped flow

A gas separator shall be provided when, subject to the provisions in 2.10.4, the pressure at the pump inlet may, even momentarily, fall below either the atmospheric pressure or the saturated vapour pressure of the liquid.

No gas elimination device is required when the pressure at the pump inlet is always greater than the atmospheric pressure and the saturated vapour pressure of the liquid, and if any gaseous formation liable to have a specific effect greater than 1% of the minimum measured quantity cannot form in or enter the inlet pipework of the meter, whatever be the conditions of use.

A gas elimination device is required when the pressure at the pump inlet is always greater than the atmospheric pressure and the saturated vapour pressure of the liquid, but gaseous formations liable to have a specific effect greater than 1% of the minimum measured quantity can occur. When applying this provision, it is necessary to consider, in particular:

(1) gaseous formations likely to occur owing to thermal contraction during shutdown periods; if gaseous formation is possible, a gas extractor is required; and

(2) air pockets likely to be introduced into the pipework when the supply tank is completely empty; in case there is a possibility of gaseous formation, a special gas extractor is required.

The gas elimination device shall be installed downstream of the pump or be combined with the pump.

If the gas elimination device is installed below the level of the meter, a non-return valve fitted, if necessary, with a pressure limiting device shall be incorporated to prevent the pipework between the two components from emptying.

The loss of pressure caused by the flow of liquid between the gas elimination device and the meter shall be as small as possible.

If the pipework upstream of the meter incorporates several high points, it may be necessary to provide one or more automatic or manual evacuation devices.

2.10.3 Non-pumped flow

When a meter is supplied by gravity without use of a pump, and if the pressure of the liquid in all parts of the pipework upstream of the meter and in the meter itself is greater than the saturated vapour pressure of the liquid and the atmospheric pressure at measuring conditions, a gas elimination device is not necessary. However, after the measuring system has been put into service, an arrangement is required to ensure that it remains correctly filled.

If the pressure of the liquid is likely to be lower than the atmospheric pressure while remaining greater than the saturated vapour pressure, an appropriate device shall prevent entry of air into the meter.

If a meter is supplied under gas pressure, the measuring system shall be so constructed that separation of air or gas is avoided. An appropriate device shall prevent entry of gas into the meter.

In all circumstances, the pressure of the liquid between the meter and the transfer point shall be greater than the saturated vapour pressure of the liquid.

2.10.4 Viscous liquids

Since the effectiveness of gas separators and gas extractors decreases as the viscosity of the liquids increases, these devices may be dispensed with for liquids with a dynamic viscosity of more than 20 mPa.s at 20°C.

In this case, it is necessary to make provisions to prevent entry of air. The pump shall be so arranged that the inlet pressure is always greater than the atmospheric pressure.

If it is not always possible to meet this condition, a device shall be provided to stop the flow of liquid automatically as soon as the inlet pressure falls below the atmospheric pressure. A pressure gauge shall be used to monitor this pressure. These provisions are not necessary if devices are provided which ensure that no air can enter through the joints in the sections of the pipework under reduced pressure and if the measuring system is so arranged that no air or dissolved gases will be released.

2.10.5 Removal of gases

The gas removal pipe of a gas elimination device shall not include a manually controlled valve if closure of this valve prevents the operation of the gas elimination device. However, if such a closing element is required for safety reasons, it shall be possible to ensure by means of a sealing device that it remains in the open position, unless closure of the valve automatically prevents further measurement.

2.10.6 Anti-swirl device

If the supply tank of a measuring system is normally to be completely emptied, the outlet of the tank shall be fitted with an anti-swirl device, unless the measuring system incorporates a gas separator.

2.10.7 General provisions for gas elimination devices

2.10.7.1 In principle, the gas separated in a gas elimination device is evacuated automatically. However, the automatic operation is not necessary if a device is provided which automatically either stops or sufficiently reduces the flow of liquid when there is a risk of air or gases entering the meter. In the case of shutdown, no measurement shall be possible unless the air or gases are automatically or manually eliminated.

2.10.7.2 The operational limits of a gas elimination device are as follows:

(a) the maximum flow rate(s) for one or more specified liquids;

(b) the maximum pressure (with no flow running) and minimum pressure (with liquid and without air intake while the pump is running at maximum flow rate) compatible with the correct operation of the gas elimination device;

(c) the minimum measured quantity for which it is designed.

2.10.8 Special provisions applicable to gas separators

2.10.8.1 Within the error limits specified in 2.10.1, a gas separator fitted in a measuring system that does not incorporate a gas indicator as specified in 2.11, shall ensure the elimination of air or gases mixed with the liquid to be measured under the following test conditions:

(a) Without air or gases the measuring system operates at the maximum flow rate and at the minimum pressure specified for the gas separator.

(b) Then air is introduced or gases are created as long as the measuring system operates. Any proportion by volume of air or gases relative to the liquid is permitted if the gas separator is designed for a maximum flow rate lower than or equal to 20 m^3/h; it is limited to 30% if the gas separator is designed for a maximum flow rate higher than 20 m^3/h (the volumes of air or gases are measured at atmospheric pressure in determining their percentages). The percentage is considered only when the meter is running.

Furthermore, when provided, the automatic gas removal device must continue to operate correctly at the maximum pressure fixed for these gas separators.

2.10.8.2 Within the error limits specified in 2.10.1, a gas separator fitted in a measuring system that incorporates a gas indicator shall ensure the elimination of air or gases mixed with the liquid to be measured under the following conditions:

(a) without air or gases the measuring system operates at the maximum flow rate and at the minimum pressure specified for the measuring system,

(b) then air is introduced or gases are created as long as the measuring system operates. The proportion by volume of air or gases relative to the liquid does not exceed:

- 20% for liquids of a viscosity not exceeding 1 mPa.s, other than potable liquids;
- 10% for potable liquids and for liquids of a viscosity exceeding 1 mPa.s.

The percentages are considered only when the meter is running.

When the proportion by volume of air or gases relative to the liquid is greater than the above mentioned percentages and when the gas separator does not meet the requirements with respect to the maximum permissible errors, the gas indicator must clearly reveal the presence of air or gas bubbles.

2.10.9 Special provisions applicable to gas extractors

A gas extractor or special gas extractor shall, at the maximum flow rate of the measuring system, ensure the elimination of an air or gas pocket of a volume (measured at atmospheric pressure) at least equal to the minimum measured quantity with no resulting additional effect greater than 1% of the minimum measured quantity.

Moreover, a special gas extractor shall also be capable of separating continuously a volume of air or gas mixed with the liquid equal to 5% of the volume of liquid delivered at the maximum flow rate without the resulting additional effect exceeding the limits fixed in 2.10.1.

Notes:

(1) A special gas extractor is used mainly in measuring systems mounted on road tankers.

(2) Installing a special gas extractor is subject to feeding conditions. Therefore, no performance is required for proportions greater than 5%.

2.11 Gas Indicator

The gas indicator shall be designed so as to provide a satisfactory indication of the presence of air or gases in the liquid.

The gas indicator shall be installed downstream of the meter. In empty hose measuring systems, the gas indicator may be in the form of a weir-type sight glass and may also be used as the transfer point.

The gas indicator may be fitted with a bleed screw or with any other venting device when it forms a high point of the pipework. No pipe must be connected to the venting device. Flow indicating devices (e.g. spinners) may be incorporated in gas indicators provided that such devices do not prevent observation of any gaseous formations which could be present in the liquid.

2.12 Transfer Point

2.12.1 Measuring systems shall incorporate a transfer point. This transfer point is located downstream of the meter in delivery systems and upstream of the meter in receiving systems.

2.12.2 Measuring systems may be of two types: 'empty hose' systems and 'full hose' systems: the term 'hose' includes rigid pipework.

2.12.2.1 Empty hose systems are, in the case of delivery equipment, measuring systems in which the transfer point is located upstream of the delivery hose. This transfer point may be in the form of either a weir type sight glass, or a closing device combined, in each case, with a system which ensures the emptying of the delivery hose after each measuring operation.

2.12.2.2 Full hose systems, in the case of delivery equipment, are measuring systems in which the transfer point consists of a closing device located in the delivery line. When the delivery line has a free end, the closing device must be installed as close as possible to this end.

2.12.2.3 In the case of receiving equipment, the same provisions apply by analogy to the reception pipework upstream of the meter.

2.13 Complete Filling of the Measuring System

2.13.1 The meter and the pipework between the meter and the transfer point shall be kept full of liquid during measurement and during shutdown periods.

When this condition is not met, especially in the case of permanent installations, the complete filling of the measuring system up to the transfer point shall be effected manually and monitored during measurement and shutdowns. To ensure complete elimination of air and gases from the measuring system, venting devices fitted with small sight glasses whenever possible shall be placed in appropriate positions.

2.13.2 The additional effect of the pipework between the meter and the transfer point shall not be greater than 1% of the minimum measured quantity due to variations in temperature, equal to:

- 10°C for exposed pipes;
- 2°C for insulated or underground pipes.

To calculate this additional effect the coefficient of thermal expansion for the liquid shall be rounded to 1.10^{-3} per degree Celsius.

2.13.3 Subject to the provisions in 2.10.3, a pressure maintaining device shall, if necessary, be installed downstream of the meter to ensure that the pressure in the gas elimination device and in the meter is always greater than both the atmospheric pressure and the saturated vapour pressure of the liquid.

2.13.4 A measuring system in which the liquid could flow in the opposite direction to that of normal flow when the pump is stopped shall be provided with a non-return valve, fitted with a pressure limiting device if necessary, when reversal of the flow could result in errors greater than the minimum specified volume deviation.

2.13.5 In empty hose measuring systems, the pipework downstream of the meter and, if necessary, the pipework upstream of the meter shall have a high point so that all parts of the measuring system always remain full.

2.13.6 In full hose measuring systems which are used for measuring liquids other than liquefied gases, the free end of the hose shall incorporate a device which prevents the draining of the hose during shutdown periods.

When a closing device is installed downstream of this device, the volume of the space between them shall be as small as possible and, in all cases, be less than the minimum specified volume deviation.

2.13.7 If the hose comprises several components, these shall be assembled either by means of a special connector which keeps the hose full, or by a connection system which is either sealed or requires the use of a special tool to be disconnected.

2.14 Draining

2.14.1 In empty hose measuring systems, draining of the delivery hose referred to in 2.12.2.1 is ensured by a venting valve. In some cases, this valve may be replaced by special devices, e.g. an auxiliary pump or a compressed gas injector.

In measuring systems intended for minimum measured quantities of less than 10 m^3, these draining devices shall operate automatically.

However, when it is not possible, for duly established technical or safety reasons, to deliver (or to receive) the measured volume contained in hoses of an empty hose measuring system (for example when measuring liquefied carbon dioxide), this volume shall be smaller than or equal to half the minimum specified volume deviation.

2.14.2 In full hose measuring systems, particularly those intended for measuring viscous liquids, the nozzle shall be so designed that it cannot retain a volume of liquid exceeding 0,4 times the minimum specified volume deviation.

2.15 Variations in the Internal Volume of Full Hoses

For full hoses in a measuring system provided with a hose reel, the increase in internal volume due to the change from the coiled hose position when not under pressure to the uncoiled hose position when under pressure without any flow of liquid, shall not exceed twice the minimum specified volume deviation.

If the measuring system is not provided with a hose reel, the increase in internal volume shall not exceed the minimum specified volume deviation.

2.16 Branches and Bypasses

2.16.1 In measuring systems intended to deliver liquids, no means shall be provided by which any measured liquid can be diverted downstream of the meter. However, two or more delivery outlets may be permanently installed and operated simultaneously or alternately, provided that any diversion of flow 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 outlets are in operation, and explanatory signs, if necessary.

For measuring systems intended to receive liquids, such provisions apply by analogy.

A manually controlled outlet may be available for purging or draining the measuring system. Effective means shall be provided to prevent the passage of liquid through any such outlet during normal operation of the measuring system.

2.16.2 In measuring systems which may operate either with an empty hose or with a full hose and which are equipped with flexible pipes, a non-return valve shall, if necessary, be incorporated in the rigid pipework leading to the full hose immediately downstream from the selector valve. In addition, the selector valve shall not, in any position, permit connection of the discharge hose, operating as an empty hose to the pipework leading to the full hose.

2.16.3 Any connections which may be provided for bypassing the meter shall be closed by means of blanking flanges. However, if the operating requirements make such a bypass necessary, it shall be closed either by means of a closing disc or a double closing device with a monitoring valve in between. It shall be possible to ensure closure by means of seals, or there shall be an automatic monitoring of the double block-and-bleed valve in the bypass giving an alarm signal in case of leakage in this valve.

2.17 Control and Closing Mechanisms

2.17.1 If there is a risk that the supply conditions can overload the meter, a flow limiting device shall be provided. This device shall be installed downstream of the meter. It shall be possible to seal it.

2.17.2 The various positions of the controls of multi-way valves shall be easily visible and located by notches, stops or other fixing devices. Deviations from this requirement are permissible when the adjacent positions of the controls form an angle of 90° or more.

2.18 Various Provisions

2.18.1 If provided, filters shall not disturb the measuring operation.

2.18.2 In the case of measuring liquid petroleum products, means for vapour recovery shall not influence the accuracy of measurements such that the maximum permissible error is exceeded.

2.19 Markings

2.19.1 Each measuring system, component or sub-system for which pattern approval has been granted shall bear, placed together legibly and indelibly either on the dial of the indicating device or on a special data plate, the following information:

(a) pattern approval sign;
(b) manufacturer's identification mark or trademark;
(c) designation selected by the manufacturer, if appropriate;
(d) serial number and year of manufacture;
(e) characteristics as defined in 2.3.1, 3.1.1.1, 2.10.7.2, or 3.1.7.1; and
(f) accuracy class, if other than 0.5.

Note: The indicated characteristics should be the actual characteristics of use, if they are known when the plate is affixed. When they are not known, the indicated characteristics are those allowed by the pattern approval certificate.

However, the minimum and the maximum temperatures of the liquids shall appear on the data plate only when they differ from –10°C and +50°C respectively.

The minimum measured quantity of the measuring system shall in all cases be clearly visible on the dial of any indicating device visible to the user during the measurement.

If several meters operate in a single system using common components, the marking required for each part of the system may be combined on a single plate.

When a measuring system can be transported without being dismantled, the markings required for each component may also be combined on a single plate.

2.19.2 Any information, markings or diagrams specified by this document or possibly by the pattern approval certificate, shall be clearly visible on the dial of the indicating device or within proximity to it.

The markings on the dial of the indicating device of a meter forming a part of a measuring system shall not contravene those on the data plate of the measuring system.

2.19.3 When volume at base conditions is indicated, these base conditions shall be clearly mentioned in the vicinity of the result of measurement, in the form:

T_b = ... °C (or K)

P_b = ... MPa (or kPa or Pa or bar)

2.20 Sealing Devices and Stamping Plate

2.20.1 General

Sealing is preferably carried out by means of lead seals. However, other types of sealing are permitted on fragile instruments or when these seals provide sufficient integrity, electronic seals for instance.

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

Sealing should 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.

It must be prohibited to change parameters which participate in the determination of the results of measurement (parameters for correction and conversion in particular) by means of sealing devices.

Except for direct selling to the public, it may be acceptable that the nature of the measured liquid or its viscosity be normally entered into the calculator at the beginning of the measurement operation (see 3.1.5, 4th paragraph) even when this datum participates in the correction. This datum and a note explaining that this quantity has been entered manually shall then be printed at the same time as the measurement results.

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 data plate of the measuring system referred to in 2.19.

In the case of a measuring system used for potable liquids, sealing shall be applied such that the equipment may be dismantled for cleaning purposes.

2.20.2 Electronic sealing devices

2.20.2.1 When access to parameters that participate in the determination of results of measurement is not protected by mechanical sealing devices, the protection shall fulfil the following provisions (except in cases related to the 5th paragraph of 2.20.1):

(a) access shall only be allowed to authorised people, e.g. by means of a code (key-word) or of a special device (hard key, etc.); the code must be changeable; access by means of only a code is not allowed in the case of direct selling to the public;

(b) it shall be possible for at least the last intervention to be memorised; the record shall include the date and a characteristic element identifying the authorised person making the intervention (see (a) above); the traceability of the last intervention shall be assured for at least two years, if it is not over-written on the occasion of a further intervention; if it is possible to memorise more than one intervention, and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted.

2.20.2.2 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 2.20.2.1 are fulfilled;

(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.

2.20.2.3 For measuring systems with parts which may be disconnected one from another by the user and which are not interchangeable, the provisions in 2.20.2.2 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.

3. REQUIREMENTS FOR METERS AND ANCILLARY DEVICES OF A MEASURING SYSTEM

3.1 Meter

The meter(s) of a measuring system shall meet the following requirements, whether or not it (they) is (are) subject to a separate pattern approval:

3.1.1 Field of operation

3.1.1.1 The field of operation of a meter is determined at least by the following characteristics:

- minimum measured quantity;
- measuring range limited by the minimum flow rate, Q_{min}, and the maximum flow rate, Q_{max};
- maximum pressure of the liquid, P_{max};
- nature of the liquid(s) to be measured and limits of kinematic or dynamic viscosity when the indication of the nature of the liquid alone is not sufficient for characterising its viscosity;
- maximum temperature of the liquid, T_{max};
- minimum temperature of the liquid, T_{min}.

3.1.1.2 The value of the minimum measured quantity shall be in the form 1×10^n, 2×10^n or 5×10^n authorised units of volume, n being a positive or negative whole number, or zero.

3.1.1.3 In general, the ratio between the maximum and the minimum flow rate of the meter shall be:

- at least equal to ten for meters for liquids having a viscosity less than 20 mPa.s at measurement temperature, other than liquefied gases,
- at least equal to five for meters for liquids having a viscosity equal to or greater than 20 mPa.s and for meters for liquefied gases.

However, when the requirements applicable to a particular measuring system specify a lower ratio for that system or its meter, the ratio for the meter may be less than specified above, without being lower than two in application of 2.3.3, 3rd paragraph.

3.1.2 Metrological requirements

3.1.2.1 The maximum permissible errors for a meter, within its field of operation, are equal to those specified in line B of Table 2.

3.1.2.2 For any quantity equal to or greater than five times the minimum measured quantity, the repeatability error of the meter shall not be higher than two-fifths of the value specified in line A of Table 2.

3.1.2.3 For a given liquid within their fields of operation, meters shall present a magnitude of the difference between the initial intrinsic error and the error after the endurance test equal to or less than the value specified in line B in Table 2.

3.1.3 Connections between the flow sensor and the indicating device

In the text, the expression ‘flow sensor’ also means ‘volume sensor’.

The connections between the flow sensor and the indicating device shall be reliable and, for electronic devices, durable, in accordance with 4.1.3 and 4.3.2.

This provision also applies to connections between primary and secondary devices for electromagnetic meters.

3.1.4 Adjustment device

Meters may be provided with an adjustment device which permits modification of the ratio between the indicated volume and the actual volume of liquid 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 0.000 5 for meters intended to equip measuring systems of class 0.3, and 0.001 for other meters.

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

3.1.5 Correction device

Meters may be fitted with correction devices; such devices are always considered as an integral part of the meter. The whole of the requirements which apply to the meter, in particular the maximum permissible errors specified in 3.1.2.1, are therefore applicable to the corrected volume (at metering conditions).

In normal operation, non-corrected volume shall not be displayed.

The aim of a correction device is to reduce the errors as close to zero as possible.

Note: National regulations should state that 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.

All the parameters which are not measured and which are necessary for correcting shall be contained in the calculator at the beginning of the measurement operation. The pattern approval certificate may prescribe the possibility of checking parameters that are necessary for correctness at the time of verification of the correction device.

The correction device shall not allow the correction of a pre-estimated drift in relation to time or volume flow, for example.

The associated measuring instruments, if any, shall comply with the applicable international standards or recommendations. Their accuracy shall be good enough to permit that the requirements on the meter be met, as specified in 3.1.2.1.

Associated measuring instruments shall be fitted with checking devices, as specified in 4.3.6.

3.1.6 Measuring systems equipped with volumetric meters

The periodic variation of a volumetric meter shall be less than half the minimum specified volume deviation.

When a volumetric meter is approved separately, the pattern approval certificate shall indicate the value of its cyclic volume.

3.1.7 Measuring systems equipped with turbine meters

3.1.7.1 The pressure downstream of the meter shall satisfy the manufacturer's specification. The minimum pressure shall be indicated on the data plate of the meter.

3.1.7.2 Measuring systems equipped with turbine meters shall be fitted with flow straightening devices for preventing, as far as possible, the liquid from any possible rotation and for regulating the flow at the inlet of the meter. These are straight pipes, or flow straighteners, or a combination of straight pipes and a flow straightener.

The flow straightening device shall be placed immediately upstream of the meter and its internal diameter shall be equal to the diameter of the inlet of the meter. In addition, application of the provisions in ISO 2715 (1981) (which is equivalent to AS 2651 (1983)) is recommended for this specific point.

The length of the necessary straight pipes and the characteristics of the flow straighteners are specified by the pattern approval of turbine meters.

3.1.7.3 Each turbine meter shall be followed by a straight pipe having an internal diameter equal to the outlet diameter of the meter and a length of at least five times this diameter.

Note: Requirements in 3.1.7.2 and 3.1.7.3 may be not fulfilled if the manufacturer's solutions ensure equivalent results.

3.1.8 Measuring systems equipped with electromagnetic meters

3.1.8.1 Measuring systems equipped with electromagnetic meters shall be fitted with a straight pipe upstream of the meter and with a straight pipe downstream of the meter.

The upstream pipe shall have an internal diameter equal to the inlet diameter of the meter and a length of at least ten times this diameter.

The downstream pipe shall have an internal diameter equal to the outlet diameter of the meter and a length of at least five times this diameter.

3.1.8.2 The time necessary for determining the minimum measured quantity at maximum flow rate, must be at least twenty times the duration of one complete cycle for meters using a.c. or pulsed d.c. field excitation.

3.1.8.3 The maximum permissible cable length between primary and secondary devices, as defined in ISO/TR 6817 (1980), shall be not more than 100 m or not more than the value L expressed in metres according to the following formula, whichever is smaller:

$$L = (k \times c) / (f \times C)$$

where $k = 2 \times 10^{-5}$ m, c is the conductivity of the liquid in S/m, f is the field frequency during the measuring cycle in hertz and C is the effective cable capacitance per metre in F/m.

Note: Requirements in 3.1.8 may be not fulfilled if the manufacturer's solutions ensure equivalent results.

3.2 Indicating Device

3.2.1 General provisions

3.2.1.1 Reading of the indications shall be precise, easy and non-ambiguous whatever position the indicating device comes to rest; if the device comprises several elements, it shall be arranged in such a way that the reading of the measured volume can be made by simple juxtaposition of the indications of the different elements. The decimal sign shall appear distinctly.

3.2.1.2 The scale interval of indication shall be in the form 1×10^n, 2×10^n or 5×10^n authorised units of volume, where n is a positive or negative whole number, or zero.

3.2.1.3 Non-significant scale intervals should be avoided. This does not apply to price indications.

3.2.1.4 The minimum specified volume deviation shall be equal to or greater than the following value:

- for continuous indicating devices, the volume corresponding to 2 mm on the scale or to one-fifth of the scale interval (of the first element for mechanical indicating devices), whichever is greater;
- for discontinuous indicating device, the volume corresponding to two scale intervals.

3.2.2 Mechanical indicating device

3.2.2.1 When the graduation of an element is entirely visible, the value of one revolution of that element shall be in the form 10^n authorised units of volume; this rule however, does not apply to the element corresponding to the maximum range of the indicating device.

3.2.2.2 On an indicating device having several elements, the value of each revolution of an element whose graduation is entirely visible must correspond to the scale interval of the following element.

3.2.2.3 An element of the indicating device may have continuous or discontinuous movement, but when elements other than the first have only part of their scales visible through the windows, these elements shall have discontinuous movement.

3.2.2.4 The advance by one figure of any element having discontinuous movement shall occur and be completed when the preceding element passes from 9 to 0.

3.2.2.5 When the first element has only a part of its scale visible through a window and has a continuous movement, the dimension of that window shall be at least equal to 1.5 times the distance between two consecutive graduated scale marks.

3.2.2.6 All scale marks shall have the same width, constant along the line and not exceeding one quarter of the scale spacing. The apparent scale spacing shall be equal to or greater than 2 mm. The apparent height of the figures shall be equal to or greater than 4 mm, unless otherwise specified in the requirements for particular measuring systems.

3.2.3 Electronic indicating device

The continuous display of volume during the period of measurement is only mandatory in the case of direct selling to the public. However, if interrupting the display of volume interrupts the action of some checking facilities that are mandatory or necessary to ensure correct measurement, the volume passing through the meter during each interruption shall be smaller than or equal to the minimum measured quantity.

3.2.4 Zero setting device for volume indicating device

3.2.4.1 A volume indicating device may be provided with a device for setting the indication to zero either by manual operation or by means of an automatic system.

3.2.4.2 The zero setting device shall not permit any alteration of the measurement result shown by the volume indicating device (other than by making the result disappear and displaying zeros).

3.2.4.3 Once the zeroing operation has begun it shall be impossible for the volume indicating device to show a result different from that of the measurement which has just been made, until the zeroing operation has been completed.

Indicating devices on fuel dispensers and electronic measuring systems shall not be capable of being reset to zero during measurement. On other measuring systems, either this provision shall be fulfilled or a clearly visible notice shall be provided on the indicating device stating that this operation is prohibited.

3.2.4.4 On continuous indicating devices, the residual indication after return to zero shall not be more than half the minimum specified volume deviation.

3.2.4.5 On discontinuous indicating devices, the indication after return to zero shall be zero without any ambiguity.

3.3 Price Indicating Device

3.3.1 A volume indicating device with aligned figures and zero setting may be complemented with a price indicating device, also with aligned figures and zero setting.

3.3.2 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.

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.

3.3.3 The provisions in 3.2 relating to volume indicating devices apply also, by analogy, to the price indicating devices.

3.3.4 The dollar or its symbol, shall appear in the immediate vicinity of the indication.

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

3.3.6 The minimum specified price deviation shall be greater than or equal to the following value:

- for continuous indicating devices, the price corresponding to 2 mm on the scale or to one-fifth of the scale interval (of the first element for mechanical indicating devices), whichever is greater;
- for discontinuous indicating devices, the price corresponding to two scale intervals.

However, the interval of one-fifth of the scale interval or of 2 mm in the case of the first hyphen or the scale interval in the case of the second hyphen need not correspond to a value less than 1 cent.

3.3.7 The difference between the indicated price and the price calculated from the unit price and the indicated volume shall not exceed the minimum specified price deviation. However this difference need not be less than 1 cent.

Moreover, this requirement does not apply when the unit price has been changed between two measurements.

3.3.8 On continuous indicating devices, the residual indication after zeroing shall not exceed half the minimum specified price deviation. However, this indication need not be less than 1 cent.

3.3.9 On discontinuous indicating devices, the indication after zeroing shall be zero without any ambiguity.

3.4 Printing Device

3.4.1 The printed scale interval shall be in the form of 1×10^n, 2×10^n or 5×10^n authorised units of volume, n being a positive or negative whole number, or zero, and shall not be greater than the minimum specified volume deviation.

The printed scale interval shall not be smaller than the smallest scale interval of the indicating devices.

3.4.2 The volume printed shall be expressed in one of the units authorised for the indication of volume.

The figures, the unit used or its symbol and the decimal sign, if any, shall be printed on the ticket by the device.

3.4.3 The printing device may also print information identifying the measurement such as: sequence number, date, identification of the dispenser, type of liquid, etc.

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

3.4.4 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’.

3.4.5 If the volume is determined by the difference between two printed values, even if one is expressed in zeros, it shall be impossible to withdraw the ticket from the printing device during measurement.

3.4.6 Where the printing device and volume indicating device each have a zeroing device, these devices shall be designed so that resetting one of them to zero also resets the other.

3.4.7 The printing device may print, in addition to the measured quantity, either the corresponding price or this price and the unit price.

In the case of 'direct selling to the public' it may also print only the price to be paid (without the volume) when it is connected to a volume indicating device and to a price indicating device both of which are visible to the purchaser.

The figures, the dollar or its symbol and the decimal sign, if any, shall be printed by the device.

3.4.8 The printed price scale interval shall be in the form 1×10^n, 2×10^n or 5×10^n monetary units, n being a positive or negative whole number, or zero; it shall not exceed the minimum specified price deviation. However, it need not be less than 1 cent.

3.4.9 If the volume indicating device is not fitted with a price indicating device, the difference between the printed price and the price calculated on the basis of the indicated volume and the unit price shall comply with the requirements in 3.3.7.

3.4.10 Electronic printing devices are also subject to the requirements in 4.3.5.

3.5 Memory Device

3.5.1 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.

3.5.2 The medium on which data are stored must have sufficient permanency to ensure that the data are not corrupted under normal storage conditions. There shall be sufficient memory storage for any particular application.

3.5.3 When the storage is full, it is permitted to delete memorised data when both the following conditions are met:

- data are deleted in the same order as the recording order and the rules established for the particular application are respected;
- deletion is carried out after a special manual operation.

3.5.4 Memorisation shall be such that it is impossible in normal use to modify stored values.

3.5.5 Memory devices shall be fitted with checking facilities according to 4.3.5. 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.

3.6 Pre-setting Device

3.6.1 The selected quantity is pre-set by operating a device provided with scales and scale marks or a numerical device which indicates that quantity. The preset quantity shall be indicated before the start of the measurement.

3.6.2 Where pre-setting is effected by means of several controls which are independent of each other, the scale interval corresponding to one control shall be equal to the pre-setting range of the control of the next lower order.

3.6.3 Pre-setting devices may be so arranged that the repetition of a selected quantity does not require a new setting of the controls.

3.6.4 Where it is possible to view simultaneously the figures of the display device of the pre-setting device and those of the volume indicating device, the former shall be clearly distinguishable from the latter.

3.6.5 Indication of the selected quantity may, during measurement, either remain unaltered or return progressively to zero. However, for an electronic pre-setting device it is acceptable to indicate the preset value on the indicating device for volume or price by means of a special operation with the restriction that this value shall be replaced by the zero indication for volume or price before the measurement operation can start.

3.6.6 In the case of a prepaid or pre-ordered delivery, the difference found under normal operating conditions, between the pre-set quantity and the quantity shown by the volume or price indicating device at the end of the measurement operation, shall not exceed the minimum specified volume or price deviation.

3.6.7 The pre-set quantities and the quantities shown by the volume indicating device shall be expressed in the same unit. This unit (or its symbol) shall be marked on the pre-setting mechanism.

3.6.8 The scale interval of the pre-setting device shall not be less than the scale interval of the indicating device.

3.6.9 Pre-setting devices may incorporate a device to permit the flow of liquid to be stopped quickly when necessary.

3.6.10 Measuring systems with a price indicating device may also be fitted with a price pre-setting device which stops the flow of the liquid when the quantity delivered corresponds to the pre-set price. The requirements in 3.6.1 to 3.6.9 apply by analogy.

3.7 Conversion Device

3.7.1 Measuring systems may be fitted with a conversion device as defined in T.1.12. The provisions of 3.7 mainly apply to electronic conversion devices in which conversion calculations are made numerically by an electronic computer. Analogous provisions could apply by analogy to mechanical conversion devices.

3.7.2 The calculation of the conversion factor shall be made according to the applicable international recommendations or standards (in particular OIML R 63 (1994)).

For temperature conversion devices the conversion factors for petroleum products are obtained from:

- ASTM–IP Petroleum Measurement Tables, metric edition, Table 54 for liquids with densities below 610.0 kg/m^3 at 15ºC; or
- API Standard 2540, Tables 54A, 54B and 54C for liquids with densities from 610.0 to 1076.0 kg/m^3 at 15ºC.

For pressure conversion devices the volume conversion factors for petroleum products are obtained from:

- API Manual of Petroleum Measurement Standards, Chapter 11.2.2M – compressibility factors for hydrocarbons: 350–637 kg/m^3 density (15ºC) and –46ºC to 60ºC metering temperature.

For conversions based on density of the liquid the densities for petroleum products are obtained from:

- ASTM–IP Petroleum Measurement Tables, metric edition, Table 53 for liquids with densities below 610.0 kg/m^3 at 15ºC; or
- API Standard 2540, Tables 53A and 53B for liquids with densities from 610.0 to 1076.0 kg/m^3 at 15ºC.

For conversion factors for other liquids (e.g. anhydrous ammonia, bitumen etc) contact NMI for the applicable tables.

3.7.3 As a rule, the parameters which characterise the measured liquid and which intervene in the conversion formula shall be measured using associated measuring instruments. However, some of these parameters may be not measured, or associated measuring instruments may be not subject to control when their influence on the conversion factor is negligible (less than one-tenth of the maximum permissible error as specified in 2.5.1).

For example, in many cases it is possible to make a conversion to volume in base conditions by measuring temperature only, when pressure and density vary little.

3.7.4 Associated measuring instruments shall comply with applicable international recommendations and standards. In addition, maximum permissible errors for these instruments are those specified in 2.7.2.

3.7.5 Associated measuring instruments shall be installed near the meter so as to determine the relevant quantities as they exist in the meter in a sufficiently accurate way.

The changes in indication due to the location of the measuring points shall not exceed 0.2 times the maximum permissible error for the measuring system. Subject to fulfilment of this requirement, the same associated measuring instruments may be used for making conversions (and corrections) for several meters.

These instruments shall not affect the correct functioning of the meter(s).

Note: These requirements are checked by calculation.

3.7.6 All the parameters which are not measured and which are necessary for the conversion shall be present in the calculator at the beginning of the measurement operation. It must be possible to print or to indicate them from the calculator.

For a mechanical conversion device that cannot print or indicate these values, a seal must be broken to change any setting.

3.7.7 In addition to the volume at metering conditions and the volume in base conditions or the mass, which shall be displayed according to 2.9.2, the values of other measured quantities (density, pressure, temperature) shall be accessible for each test measurement.

Scale intervals for density, pressure and temperature shall be smaller than or equal to one quarter of the maximum permissible errors fixed in 2.7.2. for associated measuring instruments.

3.8 Calculator

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.

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.

4. MEASURING SYSTEMS EQUIPPED WITH ELECTRONIC DEVICES

4.1 General Requirements

4.1.1 Electronic measuring systems shall be designed and manufactured such that their errors do not exceed the maximum permissible errors as defined in 2.5 under rated operating conditions.

4.1.1.1 Interruptible electronic measuring systems shall be designed and manufactured such that, when they are exposed to the disturbances specified in A.4, either:

(a) significant faults do not occur; or
(b) significant faults are detected and acted upon by means of checking facilities.

This provision may apply separately to:

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

4.1.1.2 Non-interruptible measuring systems shall be designed and manufactured in such a way that no significant faults occur when they are exposed to the disturbances specified in A.4.

4.1.2 It is the responsibility of the manufacturer to decide whether a given pattern of measuring system is interruptible or not, taking into account the applicable rules of security. However, measuring systems for direct selling to the public shall be interruptible.

When, at the time of pattern approval, it is not possible to specify the future utilisation of the instrument, the requirements in 4.1.1.2 apply.

4.1.3 The requirements in 4.1.1 shall be met durably. For this purpose electronic measuring systems shall be provided with the checking facilities specified in 4.3.

4.1.4 A pattern of a measuring system is presumed to comply with the requirements in 4.1.1 and 4.1.3 if it passes the inspection and tests specified in 6.1.11.1 and 6.1.11.2.

4.1.5 Measuring systems shall permit the retrieval of the information relating to the measured volume contained within the instrument when a significant fault occurred and was detected by checking facilities.

4.2 Power Supply Device

4.2.1 When the flow is not interrupted during the failure of the principal power supply device, the measuring system shall be provided with an emergency power supply device to safeguard all measuring functions during that failure.

4.2.2 When the flow is interrupted during the failure of the principal power supply device, the provisions in 4.2.1 shall be met, or data contained at the moment of the failure shall be 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 volume in this case is increased by 5% of the minimum measured quantity.

4.3 Checking Facilities

4.3.1 Action of checking facilities

The detection by the checking facilities of significant faults shall result in the following actions, according to the type.

4.3.1.1 Checking facilities of type N: a visible or audible alarm for the attention of the operator.

4.3.1.2 Checking facilities of types I or P:

(a) for non-interruptible measuring systems:

- automatic correction of the fault; or
- stopping only the faulty device when the measuring system without that device continues to comply with the regulations; or
- a visible or audible alarm for the operator; this alarm shall continue until the cause of the alarm is suppressed. In addition, when the measuring system transmits data to peripheral equipment, the transmission shall be accompanied by a message indicating the presence of a fault.

Note: The third point is not applicable for the disturbances specified in A.4. In addition, the instrument may be provided with devices to estimate the amount of liquid having passed through the installation during the occurrence of the fault. The result of this estimate shall not be capable of being mistaken for a valid indication.

(b) for interruptible measuring systems, in particular for dispensers:

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

4.3.2 Checking facilities for the measurement transducer

The objective of these checking facilities is to verify the presence of the transducer, its correct operation and the correctness of data transmission.

4.3.2.1 When the signals generated by the flow sensor are in the form of pulses, each pulse representing an elementary volume, at least security level B defined by ISO 6551 (1982) which is equivalent to AS 2707 (1984) is required.

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 liquid equal to the minimum specified volume deviation.

It shall be possible during pattern approval and initial verification to check that these checking facilities function correctly:

- by disconnecting the transducer; or
- by interrupting one of the sensor's pulse generators; or
- by interrupting the electrical supply of the transducer.

4.3.2.2 For electromagnetic meters only, where the amplitude of the signals generated by the measurement transducer is proportional to the flow rate, the following procedure may be used:

A simulated signal with a shape similar to that of the measurement signal is fed into the input of the secondary device, representing a flow rate between the minimum and maximum flow rate of the meter. The checking facility shall check the primary and the secondary device. The equivalent digital value is checked to verify that it is within predetermined limits given by the manufacturer and consistent with the maximum permissible errors.

This checking facility shall be of type P or I. In the latter case, the checking shall occur at least every 5 min.

Note: Following this procedure, additional checking facilities (more than two electrodes, double signal transmission etc.) are not required.

4.3.2.3 For other technologies checking facilities providing equivalent levels of security remain to be developed.

4.3.3 Checking facilities for the calculator

The objective of these checking facilities is to 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.

4.3.3.1 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 5 min, except in the case of fuel dispensers, for which it shall occur at each delivery. The objective of the checking is to verify that:

(a) the values of all permanently memorised instructions and data are correct, by such means as:
- summing up all instruction and data codes and comparing the sum with a fixed value;
- line and column parity bits (LRC and VRC);
- cyclic redundancy check (CRC 16);
- double independent storage of data; and
- 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:
- write-read routine;
- conversion and reconversion of codes;
- use of 'safe coding' (check sum, parity bit); and
- double storage.

4.3.3.2 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, check sum or double storage. In addition, the calculation system shall be provided with a means of controlling the continuity of the calculation program.

4.3.4 Checking facility for the indicating device

The objective of this checking facility is to verify that the primary indications are displayed and that they correspond to the data provided by the calculator. In addition, it aims at verifying the presence of the indicating devices, when they are removable. These checking facilities shall either have the form as defined in 4.3.4.1 or the form as defined in 4.3.4.2.

4.3.4.1 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 a fuel dispenser it is possible to determine the price to pay from the volume and the unit price).

Means may include, for example:
- for indicating devices using incandescent filaments or LEDs, measuring the current in the filaments;
- for indicating devices using fluorescent tubes, measuring the grid voltage;
- for indicating devices using electromagnetic shutters, checking the impact of each shutter;
- 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.

4.3.4.2 The checking facility for the indicating device shall include type I or type P checking of the electronic circuits used for the indicating device (except the driving circuits of the display itself); this checking shall meet the requirements in 4.3.1.2.

It shall also provide visual checking of the entire display which shall meet the following description:

(a) For fuel dispensers:
- displaying all the elements ('eights' test);
- blanking all the elements ('blank' test); and
- displaying 'zeros'

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

(b) For all other measuring systems, the test sequence as described under (a) or any other automatic test cycle which indicates all possible states for each element of the display.

This visual checking facility shall be of type I for fuel dispensers and of type N for other measuring systems, but it is not mandatory for a malfunction to result in the actions described in 4.3.1.

4.3.4.3 It shall be possible during verification to determine that the checking facility of the indicating device is working, either:

- by disconnecting all or part of the indicating device; or
- by an action which simulates a failure in the display, such as using a test button.

4.3.5 Checking facilities for ancillary devices

An ancillary device (repeating device, printing device, self-service device, memory device, etc.) with primary indications 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:

- presence of paper; and
- the electronic control circuits (except the driving circuits of the printing mechanism itself).

It shall be possible during pattern approval and other verifications to check that the checking facility of the printing device is functioning by an action simulating a printing fault, such as using a test-button.

Where the action of the checking facility is a warning, this shall be given on or by the ancillary device concerned.

4.3.6 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 inside a pre-determined measuring range.

Examples:

- four wire transmission for resistive sensors;
- frequency filters for density meters; and
- control of the driving current for 4 to 20 mA pressure sensors.

5. REQUIREMENTS SPECIFIC TO CERTAIN TYPES OF MEASURING SYSTEMS

5.1 Fuel Dispensers

Except where otherwise specified, the requirements in this clause do not apply to LPG dispensers.

5.1.1 By design, the ratio between the maximum flow rate and the minimum flow rate for these systems shall be at least ten; on site, this ratio may be smaller provided that it is not less than five.

5.1.2 When the measuring system includes its own pump, a gas elimination device shall be installed, immediately upstream of the meter inlet. Where a gas indicator is fitted, it shall not have a venting device as mentioned in 2.11.

5.1.3 When the measuring system is intended for installation in a centrally pumped system, or for a remote pump, the general provisions in 2.10 shall be applied.

If it is not intended to install a gas elimination device the manufacturer or installer has to prove that there is no risk of air intake or gas release. In this case the minimum level in the storage tank must be automatically secured and any leakage shall be checked (see also 2.10.2).

5.1.4 Fuel dispensers shall be equipped with a device for resetting the volume indicating device to zero.

The minimum height for the figures of the resettable volume indicator is 10 mm.

If these systems also include a price indicating device, this indicating device shall be fitted with a zero resetting device. The minimum height for the price indicator remains 4 mm (see 3.2.2.6).

5.1.5 When only one nozzle can be used during a delivery, and after the nozzle has been replaced, the next delivery shall be inhibited until the indicating device has been reset to zero.

When two or more nozzles can be used simultaneously or alternately, and after the utilised nozzles have been replaced, the next delivery shall be inhibited until the indicating device has been reset to zero. Moreover, by design, the provisions in the first paragraph of 2.16.1 shall be fulfilled.

The above requirements do not apply when an auxiliary hand pump is used.

5.1.6 Measuring systems having a maximum flow rate not greater than 3.6 m^3/h shall have a minimum delivery not exceeding 5 L.

5.1.7 When the measuring system is fitted with a ticket printing device which is subject to control, this printing device shall comply with the relevant requirements in 3.4. In addition, any printing operation shall prevent the continuation of the delivery until a reset to zero has been performed. However, the printing operation shall not change the quantity indicated on the indicating device.

5.1.8 Fuel dispensers shall be interruptible.

5.1.9 In addition to requirements in 4.2.2, electronic fuel dispensers shall be such that the minimum duration of operation of the display shall be either:

- at least 15 min continuously and automatically after the failure of the principal electrical supply; or
- a total of at least 5 min in one or several periods controlled manually during 1 h after the failure.

Note: If a test during pattern approval is necessary to verify that the fuel dispenser fulfils this requirement, the instrument has to be supplied with electric power normally for the 12 h which preceded the test. Before this supply the battery (if provided) may be unloaded.

In addition, fuel dispensers 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.

5.1.10 Electronic fuel dispensers shall be such that the delay time between the measurement value and the corresponding indicated value shall not exceed 500 ms.

Several fuel dispensers may have a common indicating device if and only if the first provision in 2.9.6 is met.

5.1.11 The checking of the operation of the calculator, as described in 4.3.3.1, shall be performed at least once for each delivery.

5.1.12 It is not required to display volumes, and prices if applicable, that correspond to a small number of scale intervals at the beginning of the delivery, and to start the display with that volume and the corresponding price.

The volume thus hidden shall not be greater than two times the minimum specified volume deviation. The hidden price shall not be greater than the price corresponding to that volume.

5.2 Measuring Systems on Road Tankers for the Transport and Delivery of Liquids of Low Viscosity (≤20 mPa.s) and Stored at Atmospheric Pressure, with the Exception of Potable Liquids

5.2.1 The provisions hereafter apply to measuring systems mounted on road tankers or on transportable tanks.

5.2.2 Tanks equipped with measuring systems may comprise one or more compartments.

5.2.3 The compartments of road tankers shall be fitted with an anti-swirl device, except when the measuring system is fitted with a gas separator which complies with 2.10.8.

5.2.4 When a tank comprises more than one compartment, each compartment shall be provided with an individual (manual or automatic) closing device in each outlet line.

5.2.5 In conformity with national regulations on their use, each measuring system shall be allocated to a specific product or to a range of products for which the meter has been approved.

The pipework shall, as far as possible, be designed so that products cannot become mixed in the measuring system.

5.2.6 Subject to the requirements in 2.16, a measuring system mounted on a road tanker may include empty or full hoses or both. Where several hoses are intended to operate alternatively, the changing of the delivery path shall be impossible during a measurement operation. To this end, the change of the delivery path may be linked to the resetting to zero of the volume indicating device.

5.2.7 The volume indicating device shall include a zero resetting device complying with 3.2.4.

When the measuring system is fitted with a ticket printing device, any printing operation shall prevent the continuation of the delivery until a reset to zero has been performed, except for printing devices determining the delivered volume by means of two consecutive indications.

5.2.8 Measuring systems mounted on road tankers may be designed to operate by pump only, or by gravity only, or with the choice of either pump or gravity, or by gas pressure.

5.2.8.1 Measuring systems fed by pump only may operate either empty hose or full hose.

5.2.8.1.1 If there is a risk that the requirements in 2.10.2 related to the absence of air or gas cannot be complied with, the meter shall have one of the following gas elimination devices upstream of it:

- a suitable gas separator conforming to 2.10.8;
- a special gas extractor, conforming to 2.10.9;
- a gas extractor, conforming to 2.10.9.

When, in a measuring system, the pressure at the outlet of the meter can be lower than the atmospheric pressure while remaining higher than the saturated vapour pressure of the measured product, the above devices shall be combined with an automatic system for slowing down and stopping the flow to prevent any air from entering the meter.

When the pressure at the outlet of the meter cannot be lower than atmospheric pressure (this is especially the case for systems operating solely full hose), the use of automatic devices for slowing down and stopping the flow is not required.

5.2.8.1.2 The special gas extractor shall be fitted with a sight glass.

5.2.8.2 Measuring systems operating solely by gravity shall comply with the following requirements.

5.2.8.2.1 The equipment shall be so constructed that the total contents of the compartment(s) can be measured at a flow rate greater than or equal to the minimum flow rate of the measuring system.

5.2.8.2.2 If there are connections with the gas phase in the tank of the road tanker, appropriate devices shall prevent any gas from entering the meter.

5.2.8.2.3 The requirements in 2.10.3 concerning non-pumped flow shall apply.

A pump downstream of the transfer point for increasing the flow rate may be authorised if the foregoing provisions are complied with. This pump shall not cause a fall in pressure in the meter.

5.2.8.2.4 For measuring systems which include a manual release to the atmosphere immediately downstream of the transfer point, a gas indicator is mandatory.

5.2.8.3 Measuring systems capable of being operated either by gravity or by pump shall comply with the requirements in 5.2.8.1 and 5.2.8.2.

5.2.8.4 Measuring systems operated by means of gas pressure may operate empty hose or full hose. The pipework which links the meter to the device intended to prevent any gas from entering the meter as specified in point 2.10.3 shall have no constriction or component likely to cause a pressure loss which could generate gas pockets by releasing the gas dissolved in the liquid.

These systems shall include a pressure gauge which indicates the pressure in the tank. The dial of this gauge shall indicate the range of permissible pressures.

5.3 Measuring Systems for the Unloading of Ships' Tanks and of Rail and Road Tankers using an Intermediate Tank

5.3.1 Measuring systems designed to measure volumes of liquids during the unloading of ships' tanks and of rail and road tankers may include an intermediate tank in which the liquid level determines the transfer point. This intermediate tank may be designed to ensure the elimination of gas.

The cross-section of the intermediate tank shall be such that a volume equal to the minimum specified volume deviation corresponds to a difference in level of at least 2 mm.

5.3.2 In the case of road and rail tankers, the intermediate tank shall automatically ensure a constant level, visible or detectable, at the beginning and at the end of the measurement operation. The level is considered to be constant when it settles within a range corresponding to a volume of no more than the minimum specified volume deviation.

5.3.3 In the case of ships' tanks, it is not necessary to provide for the automatic maintenance of a constant level. Where such a provision is not made, it shall be possible to measure the contents in the intermediate tank.

If the ships' tank is unloaded by means of pumps located in the bottom of the ship, the intermediate tank may be used only at the beginning and at the end of the measurement operation.

5.4 Measuring Systems for Liquefied Gases under Pressure (other than LPG Dispensers)

5.4.1 Only full hose measuring systems are authorised.

5.4.2 A pressure maintaining device, located downstream of the meter, shall ensure that the product in the meter remains in a liquid state during the measurement. The necessary pressure may be maintained either at a fixed value or at a value adjusted to suit the measurement conditions.

5.4.2.1 When the pressure is maintained at a fixed value, this value shall be at least equal to the vapour pressure of the product at a temperature 15°C above the highest possible operating temperature. It shall be possible to protect the adjustment of the pressure maintaining device with a seal.

5.4.2.2 When the pressure is adjusted to suit the measurement conditions, this pressure shall exceed the vapour pressure of the liquid during the measurement by at least 100 kPa (1 bar). This adjustment shall be automatic.

5.4.2.3 For stationary measuring systems for industrial use, the competent metrology service may authorise manually-adjustable pressure maintaining devices. The pressure at the meter outlet shall then be at least equal to the vapour pressure of the product at a temperature 15°C above the temperature of the measurement. It is then necessary to attach a diagram to the measuring system, giving the vapour pressure of the measured product as a function of its temperature. If it is anticipated that these measuring systems may have to operate unsupervised over long periods, the temperature and pressure shall be registered continuously by means of appropriate instruments.

5.4.3 A gas elimination device shall be fitted upstream of the meter. However, if it is demonstrated that no vapour release will occur during measurements a gas elimination device is not mandatory. This demonstration shall include tests under the worse conditions.

5.4.3.1 The gas separator shall comply with the general requirements in 2.10.1, either for the liquefied gas itself or for a liquid of higher viscosity.

However, because of the low viscosity of liquefied gases and due to the difficulty of control, it is accepted that when the length of the pipework linking the meter to the feed tank does not exceed 25 m, a gas separator may be approved if its useful volume is at least equal to 1.5% of the volume delivered in 1 min at maximum flow rate. When the length of this pipework exceeds 25 m, the useful volume of the gas separator shall be at least equal to 3% of the volume delivered in 1 min at maximum flow rate.

The gas outlet pipe of the separator may be connected to the space in the feed tank which contains the gaseous phase, or to an independent pressure maintaining device set to a pressure from 50 to 100 kPa (0.5 to 1 bar) lower than the pressure at the meter outlet. This pipe may incorporate a shutoff valve, which meets the requirements in 2.10.5.

5.4.3.2 The volume of the condenser tank depends on the volume of the pipework between the supply tank valve and the pressure maintaining valve, downstream of the meter. The volume of this condenser tank shall be at least equal to twice the reduction in volume of the liquid which is likely to occur between these valves if the temperature drops by a value conventionally fixed at 10°C for exposed pipes and 2°C for insulated or underground pipes.

To calculate the contraction, the coefficient of thermal expansion shall be rounded to 3×10^{-3} per degree Celsius for propane and propylene and 2×10^{-3} per degree Celsius for butane and butadiene. For other products with a high vapour pressure, the values of the coefficient to be adopted shall be specified by the competent metrology service.

The condenser tank shall be fitted with a manual blow off valve. It shall be fitted at the high point in the pipework of the measuring system of which it is part.

The volume resulting from the above calculation may be divided between several condenser tanks located at high points in the pipework.

5.4.4 A thermometer well or, when this thermometer well is not imposed by specific professional practices, another means for measuring temperature, shall be provided close to the meter. The thermometer used shall have a scale interval not exceeding 0.5°C and shall be verified.

Provisions shall be made for fitting a pressure measuring device between the meter and the pressure maintaining device. This measuring device shall be available for verification. If necessary, provisions for sealing shall be made.

5.4.5 When the volume is measured using a system mounted on a road tanker, any connection between the gaseous phases of the vehicle's tank and of the receiving tank is prohibited unless it is essential for completing a measurement, in which case a non-return valve is mandatory.

For other measuring systems for liquefied gas, such connections are permitted when the volumes of gas transferred via these connections are measured by means of suitable measuring instruments.

5.4.6 Safety valves may be incorporated in measuring systems in order to prevent abnormally high pressures. If they are located downstream of the meter, they shall open to the atmosphere or be connected to the receiving tank.

In no case shall the safety valves located upstream of the meter be connected to the valves located downstream by pipes which bypass the meter.

5.4.7 When the conditions of operation require the use of detachable hoses, these hoses shall remain full if their volumes are greater than the minimum specified volume deviation.

Detachable full hoses shall be fitted with special connections for full hoses, so-called couplers or self-sealing valves. Manually operated blow-off devices shall be provided at the ends of these hoses, if necessary.

5.4.8 The control valve of the double closing device mentioned in 2.16.3 for pipework bypassing the meter, if provided, may be closed for safety reasons. In this case, any leakage shall be monitored by a pressure gauge located between the two shut off valves or by any other equivalent system.

5.4.9 For measuring systems mounted on road tankers the volume indicating device and its printing device, if provided, shall comply with the requirements in 5.2.7.

5.4.10 The provisions in 5.4 also apply for measuring systems for liquefied carbon dioxide with the following exceptions:

- Only empty hose measuring systems are authorised (see 5.4.1).
- The connection between the gaseous phases of the vehicle's tank and of the receiving tank is authorised if: (i) a device is installed to allow compensation of the delivered quantity by an amount relating to the quantity of vapour returned in the gas line, or (ii) compensation is made by automatic or manual calculation. However, in both cases, flow from the delivery tank to the receiving tank by means of the gas return line shall be securely prevented (see 5.4.5).
- The requirements of 5.4.7 are not mandatory for these systems.

5.5 Measuring Systems for Milk

5.5.1 The following requirements apply to transportable measuring systems which are mounted on road tankers and used for the collection of milk, to fixed measuring systems used for the reception of milk at the dairy, and to fixed or transportable measuring systems used for the delivery of milk.

5.5.2 The transfer point in reception installations is defined by a constant level in a tank upstream of the meter. It must be possible to check this constant level before and after each measurement. The level shall be established automatically.

5.5.2.1 When the meter is fed by means of a pump, the constant level tank may be placed either upstream of the pump or between the pump and the meter.

5.5.2.1.1 If the constant level tank is placed upstream of the pump, the tank itself may be fed by gravity, by emptying milk churns, by means of an auxiliary pump or by means of a vacuum system.

If the milk is introduced by means of a pump or a vacuum system, a gas elimination device is necessary. This device may be combined with the constant level tank.

5.5.2.1.2 If the constant level tank is placed between the pump and the meter, this tank shall ensure that gas is eliminated.

5.5.2.2 Notwithstanding the requirements of 2.13.3, the meter may be fed by means of a vacuum system. In this case, the pressure inside the pipework connecting the constant level tank to the meter will be lower than atmospheric pressure and the tightness of the joints of this connection must be particularly well ensured. It must be possible to check the tightness and a notice plate drawing attention to this checking shall be provided.

5.5.2.3 In all installations for reception, the pipework upstream of the constant level device shall empty completely and automatically under the rated operating conditions.

5.5.2.4 The constant level is monitored by means of a sight glass or a level indicating device. The level is considered to be constant when it settles within a range defined by two marks at least 15 mm apart and corresponding to a difference in volume of no more than twice the minimum specified volume deviation.

5.5.2.5 If, in order to meet the above condition, devices for reducing the flow rate are incorporated in the measuring system, the flow rate during the period of reduced flow rate shall be at least equal to the minimum flow rate of the meter.

5.5.2.6 If, in a reception installation at a dairy, the measured liquid flows to a level lower than that of the meter, a device shall automatically ensure that the pressure at the outlet of the meter remains above atmospheric pressure.

5.5.2.7 If a volume of liquid is required to fill the measuring system prior to the first measurement, it shall be indicated on the data plate of the measuring system so that it can be taken into account, by calculation, in the first measurement of a reception period. The first volume measured by the measuring system during a reception period shall be equal to or greater than the volume which is necessary for the complete filling of the measuring system.

5.5.3 Measuring systems used for delivery shall comply with the general requirements in 2 and with those in 3.

5.5.4 Notwithstanding the general requirements in 2.10 concerning the elimination of air or gases, the gas elimination devices shall comply with the requirements in 2.10.1 solely under the conditions of use, i.e. with entry of air at the beginning and end of each measuring operation of delivery.

The mounting of delivery installations shall be such that the pressure of the liquid at the level of the joint to the supply tank is always greater than atmospheric pressure.

5.5.5 The volume indicating device of a transportable measuring system and its printing device, if provided, shall comply with the requirements in 5.2.7.

5.6 Measuring Systems on Pipeline and Systems for Loading Ships

5.6.1 The ratio between the maximum flow rate and the minimum flow rate of the meter of the measuring system may be less than the value specified in the relevant paragraph in 3.1.1.3.

In this case, the measuring system shall be fitted with an automatic checking device to verify that the flow rate of the liquid to be measured is within the restricted measuring range of the measuring system.

This checking device shall be of type P and shall meet the requirements in 4.3.1.2.

The maximum and minimum flow rates may be determined in relation to the liquid to be measured and manually introduced into the calculator.

5.6.2 Prevention of gas flow

The measuring system shall be provided with a means of eliminating any air or gas contained in the liquid unless the entry of air into the liquid or release of gas from the liquid is prevented by the configuration of the pipework or by the arrangement and operation of the pump(s).

5.6.3 Special conditions of installation

Reverse flow of the liquid to be measured in the measuring system shall be prevented by a suitable device, unless otherwise approved.

5.6.4 Sampling device

The measuring system may include a sampling device intended to determine the properties of the liquid to be measured.

It is not necessary to take into account the volume of the sample in the results of the measurement if this sample is less than 0.1 times the maximum permissible error of the measuring system.

5.6.5 Testing devices

Measuring systems in pipelines should be provided with devices allowing verification of the systems in situ. However, this principle may be waived provided that:

- the meters are verified on a control test station with liquids having the same characteristics as those to be measured at the place of installation. The verification is carried out on the measurement transducer only, associated with a compatible and equivalent indicating device, provided that all the elements having a direct mechanical link with the measurement transducer and being able to influence the measurement are verified at the same time,
- the meters benefiting from this exemption shall be subject to periodic calibration controlled and fixed by the metrology service, and
- to complete the verification, the measuring systems concerned shall be subjected to a qualitative check of function and installation, in situ.

Subject to this exemption, the measuring systems shall be constructed so that a standard of appropriate size can be fitted for testing the meters. When a test can only be carried out with the pumps running, which normally does not allow for testing with the meter stopped at the start and at the end of the test, the standard shall be suitable for continuous operation (for example, volume standard with a flow diverting mechanism, pipe prover etc.).

Moreover, these capacities shall represent at least 10 000 scale intervals of the indicating device of the meter to be verified or of the auxiliary indicating device used for the test or 10 000 electrical pulses of the measurement transducer. However, a lower capacity may be permitted if a visual or automatic interpolation allows one to ascertain the indication of the meter with an error smaller than or equal to one per ten thousand of this capacity.

Furthermore, it shall be possible to carry out a metrological test of the associated measuring instruments which may be incorporated and which aim at measuring density, viscosity, pressure and temperature, under actual operating conditions.

5.7 Fuel Dispensers for Liquefied Gases under Pressure (LPG Dispensers)

5.7.1 Requirements in 5.1.1, 5.1.4 and 5.1.7 to 5.1.12 are applicable to LPG dispensers for motor vehicles. However, the ratio between the maximum flow rate and the minimum flow rate shall be at least five by design.

5.7.2 Requirements in 5.4.1, 5.4.2, 5.4.2.1, 5.4.2.2, 5.4.3, 5.4.3.1 and 5.4.3.2 are applicable to LPG dispensers for motor vehicles.

5.7.3 A thermometer well shall be provided close to the meter. The thermometer used shall have a scale interval not exceeding 0.5°C and shall be verified.

Provision shall be made for fitting a pressure measuring device between the meter and the pressure maintaining device. This measuring device shall be available for verification. If necessary, provision for sealing shall be made.

5.7.4 Connection between the gas phases of the feed tank and of the vehicle's tank is prohibited.

5.7.5 When only one nozzle can be used during a delivery, and after the nozzle has been replaced, the next delivery shall be inhibited until the indicating device has been reset to zero.

When two or more nozzles can be used simultaneously or alternately, and after the utilised nozzles have been replaced, the next delivery shall be inhibited until the indicating device has been reset to zero. Moreover, by design, the provisions in the first paragraph of 2.16.1 shall be fulfilled.

Moreover, in both cases, when the flow is stopped by emergency means and a predetermined delay is exceeded, the current delivery shall be stopped and the next delivery shall be preceded by a reset to zero.

5.7.6 A non-return valve, located between the gas elimination device and the meter, is mandatory. The pressure loss caused by it shall be sufficiently low to be considered negligible.

5.7.7 Hoses shall be fitted with special connections for full hoses, so-called couplers or self-sealing valves.

5.7.8 Safety features shall not affect the metrological performance.

5.7.9 The measuring system shall be provided with a conversion device and it shall be possible to verify separately the indications of volume at measuring conditions and associated measuring instruments.

5.7.10 Closing valves in vapour return lines shall automatically result in stopping the delivery or preventing the start of the next delivery, unless these valves have been sealed in the open position.

5.7.11 The construction of the nozzle shall be such that, at the moment of coupling or uncoupling, the loss of liquid does not exceed the minimum specified volume deviation.

5.8 Measuring Systems Intended for the Refuelling of Aircraft

The requirements of this clause also apply to the refuelling of helicopters.

5.8.1 General

5.8.1.1 Measuring systems intended for refuelling aircraft are full hose measuring systems.

5.8.1.2 The gas elimination device function may be performed by a microfilter water elimination device provided that provisions in 2.10 are fulfilled.

5.8.1.3 They shall be interruptible measuring systems.

5.8.2 Stationary measuring systems

5.8.2.1 The requirements applicable to fuel dispensers apply to stationary measuring systems intended for the refuelling of aircraft, except those in 5.1.1.

5.8.2.2 These systems may include their own pumps or be designed for installation in a centrally pumped system.

5.8.2.3 The microfilter-water elimination device shall be fitted upstream of the gas elimination device when these devices are separate one from another.

5.8.3 Mobile measuring systems

5.8.3.1 General

5.8.3.1.1 If more than one transfer point is provided, interlocks should prevent the usage of two or more together unless the arrangement is such that it would be difficult to use them on different aircrafts at the same time.

5.8.3.1.2 They may be designed for defuelling aircraft provided that the connecting point for defuelling is located upstream of the gas elimination device. A weir-type sight glass is not mandatory.

Interlocks may also be necessary to prevent bypassing metered liquid through the return line back to the supply tank while delivering fuel to the aircraft.

5.8.3.1.3 Where the microfilter-water elimination device may be used to perform the function of the gas elimination device, it may be verified by an examination of documents only if provisions in 2.10 are fulfilled.

5.8.3.1.4 Each installation shall be provided with or accompanied by:

- instructions for use;
- a liquid circulation plan;
- a description of necessary operations for use; and
- a description of control and connecting devices positions related to their use.

5.8.3.2 Aircraft refuelling tanker measuring systems

The requirements in 5.2.2, 5.2.3, 5.2.4, 5.2.6, 5.2.7 and 5.2.8.1 apply.

Note: For good practice in the use of the system, when the aircraft refuelling tanker measuring system is fitted with a device used to perform the gas extractor or special gas extractor function, a manometer should be provided upstream of the pump in order to detect depressions when they occur. Its indications should be easily visible by the operator.

5.8.3.3 Aircraft hydrant measuring systems

5.8.3.3.1 The gas elimination device may be a device performing the function of a gas extractor when the underground pipe:

- is designed for easy elimination of the air contained in the pipe with appropriate devices;
- is fitted with special connecting devices for full hoses;
- is supplied so that, in designed supply conditions, no gaseous formation can occur or enter the underground pipe.

5.8.3.3.2 When the aircraft hydrant measuring system is equipped with a device for froth recovery and reinjection, it shall be located upstream of the gas elimination device and it shall not permit permanent introduction of gas into the meter.

5.8.3.3.3 Depressurisation valves for the hoses so that connection and disconnection can be easily made, shall be accompanied with interlocks to prevent metered liquid from being diverted.

5.9 Blend Dispensers

5.9.1 The requirements in 5.1.1 to 5.1.4 and 5.1.6 to 5.1.12 are applicable to both parts of the multigrade-dispenser and to the petrol part of the petrol-oil-dispenser. However, by design, the ratio between the maximum flow rate and the minimum flow rate may be at least five in the case of multigrade-dispensers.

5.9.2 When only one nozzle can be used during a delivery, and after the nozzle has been replaced, the next delivery shall be inhibited until the indicating device has been reset to zero.

When two or more nozzles can be used simultaneously or alternately, and when the utilised nozzles have been replaced, the next delivery shall be inhibited until the indicating device has been reset to zero. Moreover, by design, the provisions in the first paragraph of 2.16.1 shall be fulfilled.

5.9.3 The requirements in 5.9.4 through 5.9.8 do not apply if the designations of the various mixtures do not allow conclusions to be drawn concerning the ratio of volumes of the two components.

Examples for such designations:
- number of stars (2, 3, 4 stars);
- octane-number (92, 95, 98 octane); and
- two-stroke-mixture (without designation such as 5%).

Moreover, the requirement in 5.9.4 or 5.9.5 only applies where the measuring system provides the indication of the mixed volume and the price of the mixture depends on the blending ratio. It does not apply where the measuring system provides:
- an indication of the mixed volume and the price does not depend on the blending ratio; or
- a volume indication for each component of the mixture and does not provide an indication of the mixed volume.

To permit compliance with the requirement in 5.9.4 or 5.9.5 to be verified, it is necessary:
- for multigrade-dispensers s to measure the volumes of both components;
- for petrol-oil-dispensers to measure either the volumes of oil and petrol or the volumes of oil and mixture;
- for both types to make the separate collection of both components feasible during verification.

5.9.4 The accuracy of the blending ratio for multigrade-dispensers shall be as follows.

The designations of the various mixtures being indicated as the ratio of volumes of the two components (for example 1:1), the real ratio of the volumes of two components shall be within the limits of ± 5%, i.e. the real ratio $k_{real} = V_2/V_1$ of volumes of both components determined during the verification shall be equal to the nominal (indicated) ratio k_{nom}, within the limits:

$$k_{min} = k_{nom} - 0.05\ k_{nom} \text{ and } k_{max} = k_{nom} + 0.05\ k_{nom}$$

Examples:

Designation	3:1	1:1	1:3
k_{nom}	0.333	1.00	3.00
k_{min}	0.316	0.95	2.85
k_{max}	0.350	1.05	3.15

5.9.5 The accuracy of the blending ratio for petrol-oil-dispensers shall be as follows.

If V_1 is the volume of the minority component in the mixture and V_2 the volume of the majority component, the real volumetric ratio related to the minority component, expressed as a percentage [$T = 100 \times V_1 / (V_1 + V_2)$], shall be equal to the nominal ratio within a limit of plus or minus:

- 5% in relative value;
- 0.2% absolute, whichever is greater.

In other words, T being the real volumetric ratio as a percentage, and T_{nom} the nominal volumetric ratio as a percentage, the following must be satisfied:

- $\geq T - T_{nom} \geq / T_{nom} \leq 0.05$ if the nominal volumetric ratio is at least 4%, and
- $\geq T - T_{nom} \geq \leq 0.2\%$ if the nominal volumetric ratio is less than 4%.

5.9.6 If the blend dispenser is capable of delivering more than one mixture with the same nozzle, the installation of two hoses and a special blending device close to the transfer point is required.

If the blend dispenser can deliver only one mixture per nozzle, the blending device may be installed inside the dispenser, using a single hose per nozzle.

5.9.7 If the blend dispenser is capable of delivering one or both single components (in addition to the mixtures) with a common nozzle, a device shall prevent the liquid flow through the unused part of the blend device.

5.9.8 The lubricating oil part of a petrol-oil-dispenser shall be designed so as to prevent air bubbles in the oil passing through the oil measuring device. There shall also be a device to detect the presence of oil. In the absence of oil, delivery has to be stopped by means, e.g. of:

- an intermediate oil reservoir and a device which stops the delivery when the oil reservoir is empty;
- a pressure detecting device which stops the delivery in the case of an oil pressure drop.

5.10 Self-service Arrangement with Fuel Dispensers

The following requirements apply to measuring systems covered by 5.1, 5.7 or 5.9 when fitted with self-service arrangements.

5.10.1 General requirements

5.10.1.1 Marking, sealing and connection of the components are as described in the certificate of approval.

5.10.1.2 Where the self-service device serves two or more dispensers, each dispenser shall be provided with a dispenser identification number that shall accompany any primary indication provided by the self-service device.

5.10.1.3 The primary indications on indicating devices and printing devices of the self-service arrangement shall not indicate any mutual differences.

The scale intervals of the primary indication on indicating devices and the printing devices and memory devices of the self-service arrangement shall be the same.

5.10.1.4 Printing devices on the self-service arrangement shall not reproduce the indications of a dispenser as the difference between two printed values.

5.10.1.5 Indication of information that is not subject to metrological control is allowed, provided that it cannot be confused with metrological information.

5.10.1.6 The control device of the self-service device should be capable of indicating the status of the dispensers (e.g. running, authorised or unauthorised) 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.

5.10.1.7 A change of the type of payment and/or mode of operation shall not be effective before the end of the current measurement operation.

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

5.10.1.9 In the case of a self-service arrangement that totalises the delivered volumes for different registered customers over the course of time, the minimum measured quantity is not affected by the scale interval used for such totalisations.

5.10.2 Attended service mode

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

5.10.2.1 Attended post-payment

5.10.2.1.1 Where the self-service arrangement includes a device that provides an additional primary indication (additional to those of the indicating device of the dispenser), it shall consist of at least one installation for the reproduction of the volume and/or the price indicated by the dispenser indicating device, consisting of:

- a printing device for the issue of a receipt to the customer; or
- an indicating device for the benefit of the supplier together with a display for the benefit of the customer.

Note: As a consequence of 3.4.7, the reproduction of the volume and price is necessary when the dispenser can be authorised before the settlement of the transaction.

5.10.2.1.2 For self-service devices with temporary storage (temporary storage mode) of measurement data of dispensers the following requirements apply:

(a) temporary storage of measurement data shall be restricted to one delivery for each dispenser;
(b) the primary indication shall be accompanied by a clear mark representing the sequence. For example, the number 1 or 2 or the letter A or B;
(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 dispenser indicating device remains the primary indication.

5.10.2.1.3 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 dispenser indicating device remains the primary indication.

5.10.2.2 Pre-payment in attended service mode

5.10.2.2.1 The requirements of 3.6 are applicable.

5.10.2.2.2 A printed or hand-written receipt of the pre-paid amount shall be provided.

5.10.3 Unattended service mode

5.10.3.1 General

5.10.3.1.1 The self-service arrangement shall provide additional primary indications by means of:

- a printing device for the issue of a receipt to the customer; and
- a device (printing or memory device) on which measurement data are registered for the benefit of the supplier.

5.10.3.1.2 When the printing devices or memory device, as required by 5.10.3.1.1, 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.

5.10.3.1.3 Where the self-service arrangement is used by registered customers, the provisions of 5.10.3.1.1 and 5.10.3.1.2 do not apply to measurements related to such customers. An additional individual volume totaliser is considered to provide a primary indication.

5.10.3.1.4 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.

5.10.3.1.5 When a power supply failure occurs, the delivery data shall be memorised. The requirements of 5.1.9 apply.

5.10.3.2 Delayed-payment

The printed and/or memorised indications as mentioned in 5.10.3.1 shall contain sufficient information for further checking and at least, the measured quantity, the price to pay and information to identify the particular transaction (e.g. the dispenser number, location, date, time).

5.10.3.3 Pre-payment in unattended service mode

5.10.3.3.1 Following the termination of each delivery, the printed and/or memorised indications as intended in 5.10.3.1 shall be made available, clearly indicating the amount which has been pre-paid and the price corresponding to the liquid obtained.

These printed and/or memorised 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 recognisable 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.

5.10.3.3.2 The requirements of 3.6 are applicable.

5.11 Other Self-service Arrangements

Measuring systems, especially those for loading road or rail tankers, may be designed in such a way that the transaction is not settled when the customer leaves the loading site, in implicit agreement with the supplier.

In this case the self-service arrangement shall provide additional primary indications by means of:

- a printing device for the issue of a receipt to the customer, and
- a device (printing or memory device) on which measurement data are registered for the benefit of the supplier.

The printed and/or memorised indications shall contain sufficient information for further checking and at least the measured quantity and information to identify the particular transaction (e.g. the system number, location, date, time).

Moreover, after a delivery, measuring systems shall not be capable of being reset to zero and authorised until measurement data are memorised or printed out.

6. METROLOGICAL CONTROL

When a test is conducted, the expanded uncertainty of the determination of errors on indications of volume or mass shall be less than one-fifth of the maximum permissible error applicable for that test on pattern approval and one-third of the maximum permissible error applicable for that test on other verifications. The estimation of expanded uncertainty is made according to the *Guide to the Expression of Uncertainty in Measurement* (1995 edition, published by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML) with k = 2.

The working standards and their use are the subject of OIML R 119 and OIML R 120.

6.1 Pattern Approval

6.1.1 General

Measuring systems subject to legal metrology control shall be subject to pattern approval. In addition, the constituent elements of a measuring system, mainly those listed below, and the sub-systems which include several of these elements, may be subject to separate pattern approval:

- meter;
- transducer;
- gas separator;
- gas extractor;
- special gas extractor;
- electronic calculator (including the indicating device);
- conversion device;
- ancillary devices providing or memorising measurements results;
- pre-setting device;
- densitometer; and
- temperature sensor.

Note: The expression ‘pattern approval’ can be for complete measuring systems or of constituent elements making it possible to certify the conformity of the pattern of a constituent element to the document.

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

Unless otherwise specified in this document, a measuring system should fulfil the requirements without adjustment of the system or of its devices during the course of the tests. If an adjustment is carried out, this condition shall still be considered as valid.

6.1.2 Documentation

6.1.2.1 The application for pattern approval of a measuring system or of a constituent element of a measuring system shall include the following documents:

- a description giving the technical characteristics and the principle of operation;
- a drawing or photograph;
- a list of the components with a description of their constituent materials when this has a metrological influence;
- an assembly drawing with identification of different components;
- for measuring systems, the references of the approval certificates of the constituent elements, if any;
- for measuring systems and meters fitted with correction devices, a description of how the correction parameters are determined;
- a drawing showing the location of seals and verification marks; and
- a drawing of regulatory markings.

6.1.2.2 In addition, the application for pattern approval of an electronic measuring system shall include:

- a functional description of the various electronic devices;
- a flow diagram of the logic, showing the functions of the electronic devices; and
- any document or evidence which shows that the design and construction of the electronic measuring system comply with the requirements of this document, in particular 4.3.

6.1.2.3 The submittor shall provide the body responsible for the evaluation with an instrument representative of the final pattern.

Other specimens of the pattern may be considered necessary by the body responsible for the pattern evaluation to estimate the reproducibility of the measurements (see 6.1.5.2.4).

6.1.3 Pattern approval certificate

The following information shall appear on the pattern approval certificate:

- name and address of the recipient of the approval certificate;
- name and address of the manufacturer, if it is not the recipient;
- type and/or commercial designation;
- principal metrological and technical characteristics;
- pattern approval mark;
- period of validity;
- environmental classification, if applicable (see annex A.1);
- information on the location of marks for pattern approval, initial verification and sealing (e.g. picture or drawing);
- list of documents accompanying the pattern approval certificate; and
- specific remarks.

When applicable, the version of the metrological part of the evaluated software shall be indicated in the pattern approval certificate or in its annexes (technical file).

6.1.4 Modification of an approved pattern

6.1.4.1 The recipient of the pattern approval shall inform the body responsible for the approval of any modification or addition which concerns an approved pattern.

6.1.4.2 Modifications and additions shall be subject to a supplementary pattern approval when they influence, or are likely to influence, the measurement results or the instrument's regulatory conditions of use.

The body having approved the initial pattern shall decide to which extent the examinations and tests described below shall be carried out on the modified pattern in relation with the nature of the modification.

6.1.4.3 When the body having approved the initial pattern judges that the modifications or additions are not likely to influence the measurement results, this body allows the modified instruments to be presented for initial verification without granting a supplementary pattern approval.

A new or supplementary pattern approval must be issued whenever the modified pattern no longer fulfils the provisions of the initial pattern approval.

6.1.5 Pattern approval of a meter or of a measurement transducer

6.1.5.1 A pattern approval may be given for a complete meter; it may also be given for the measurement transducer only (as defined in T.1.2) when this is intended to be connected to different types of calculators.

The following examinations and tests shall be carried out on the meter alone or on the measurement transducer when it is the subject of a separate application for pattern approval. They may also be carried out on the whole measuring system.

Tests are normally carried out on the complete meter, fitted with an indicating device, with all the ancillary devices and with the correction device, if any. However, the meter subject to testing need not be fitted with its ancillary devices when the latter are not likely to influence the accuracy of the meter and when they have been verified separately (for example: electronic printing device). The measurement transducer may also be tested alone provided that the computing and indicating device has been subject to a separate pattern approval. If this measurement transducer is intended to be connected to a calculator fitted with a correction device, the correction algorithm as described by the manufacturer must be applied to the output signal of the transducer to determine its errors.

6.1.5.2 Accuracy tests

6.1.5.2.1 The errors of the meter shall be determined at a minimum of six flow rates which are distributed over the measuring range at regular intervals. At each flow rate the errors shall be determined at least three times, independently. Each error shall not be greater than the maximum permissible error (in absolute value). In addition, for quantities equal to or greater than five times the minimum measured quantity, the repeatability requirement in 3.1.2.2 applies.

6.1.5.2.2 Tests should be carried out at the limits of the field of operation, i.e. at the limits of pressure, temperature and viscosity. However, pressure tests are not necessary when the technology of the meter is such that it is possible to calculate the influence of pressure and to show that it is negligible (for example: meter with pressure-balanced measuring chambers).

Note: It is often unnecessary to carry out tests with liquids having a temperature which

differs from the ambient temperature when the meter is intended to measure liquids having a temperature between –10°C and +50°C.

6.1.5.2.3 The following tests shall also be carried out:

- accuracy test at minimum measured quantity;
- determination of the periodic variation, if appropriate;
- tests with flow disturbances, if appropriate.

For tests with flow disturbances, the applicable maximum permissible errors are those fixed in 2.5 for the measuring system and not those fixed in 3.1.2 for the meter.

6.1.5.2.4 When preliminary verification of the meter is planned to be carried out with a liquid which differs from the liquid the meter is intended to measure, comparative tests with these two liquids shall also be carried out to determine the maximum permissible errors on preliminary verification. It may be necessary to have several specimen of the pattern available.

Example:

It is necessary to make a distinction between a pattern of a meter intended to measure several products (in the same measuring system) and a pattern of a meter of which different copies may be used for measuring different products (in different measuring systems), each copy being intended to measure a given product only.

For example, meter A may be intended to measure butane and propane alternatively, whereas meter B is intended to measure either butane or propane. Both meters will be subject to accuracy tests with butane and with propane at the time of pattern approval. For meter A, the error curves for propane and for butane shall both be within the maximum permissible errors as specified in 3.1.2.

For meter B, the error curves for butane on the one hand, and for propane on the other hand, shall satisfy the maximum permissible errors; unlike meter A, however, these error curves may be determined using different copies of the meter, or alternatively on the same copy whose adjustment (or correction parameters) has been modified between the test with butane and the test with propane.

Copies of meter A will bear the mention of butane and propane on their data plate and they may also be used to measure mixtures of butane and propane in any proportion.

Copies of meter B will bear either the mention ‘butane’ or the mention ‘propane’ and shall be used for measuring the corresponding product exclusively.

The preliminary verification of pattern A copies may be carried out with either butane or propane, indifferently (with, if appropriate, a reduction of the maximum permissible errors range).

In general, the preliminary verification of pattern B copies will be carried out with the liquid intended to be measured; however, it may be carried out with the other liquid provided that the maximum permissible errors have been shifted. The value of shifting shall be determined at the time of pattern evaluation by evaluating the deviation between the error curves determined with butane and with propane, on the same meter, without modification of the adjustment. These deviations shall be reproducible, from one copy of the meter to another. To check this, it is necessary to carry out accuracy tests on several instruments.

6.1.5.3 Endurance tests

Endurance tests should be carried out at the maximum flow rate of the meter using the liquid the meter is intended to measure or a liquid with similar characteristics. When the meter is

intended to measure different liquids, the test should be carried out with the liquid that provides the most severe conditions.

An accuracy test shall precede the endurance tests.

In principle the duration of the endurance test shall be 100 h in one or several periods. In specific cases (e.g. new technologies, new alloys, new liquids) the duration may be increased up to 200 h.

The test shall be carried out at a flow rate between $0.8 \times Q_{max}$ and Q_{max}.

As far as possible, the meter is subjected to the endurance test on a test bench. However, it is accepted that the meter be temporarily mounted in a measuring system in normal operation, in which case it is necessary that the nominal operating flow rate of the measuring system is more than $0.8 \times Q_{max}$.

After the endurance test, the meter is again subject to a new accuracy test. The deviations between the errors determined before and after the endurance test shall remain within the limits specified in 3.1.2.3 without any changes of the adjustment or corrections.

6.1.6 Pattern approval of a gas elimination device

As a rule, tests shall be carried out to prove that the air or gas eliminating devices satisfy the requirements in 2.10.8 or 2.10.9.

It is however acceptable that tests are not carried out at flow rates greater than 100 m^3/h and that the air separating devices are approved by analogy with devices of the same design, having smaller dimensions (see B.1.1.5).

Annex B describes tests which should be carried out on these devices. These tests are given as examples only.

6.1.7 Pattern approval of an electronic calculator

When an electronic calculator is submitted to separate pattern approval, pattern approval tests are conducted on the calculator alone, simulating different inputs with appropriate standards.

6.1.7.1 Accuracy tests include an accuracy test on the indications of measurement results (volume at metering conditions or price to pay). For this purpose, the error obtained on the indication of the result is calculated considering the true value is the one calculated taking into account the value of the simulated quantities applied to inputs of the calculator and using standard methods for calculation. The maximum permissible errors are those fixed in 2.8.

6.1.7.2 When the calculator carries out calculations for a conversion device, tests specified in 6.1.7.1 are performed for the calculation of volume at base conditions or mass.

Accuracy tests also include an accuracy test on the measurement of each characteristic quantity of the liquid. For this purpose, the error obtained on the indication of each of these characteristic quantities (these indications are mandatory considering 3.7.7) is calculated by considering the true value as that provided by the standard connected to the inputs of the calculator and which simulates the corresponding associated measuring instrument. For each of these quantities, the maximum permissible errors fixed in 2.7.3 shall be applied.

It is then necessary to perform a test to check the presence and operation of checking facilities relevant to associated measuring instruments mentioned in 4.3.6.

6.1.7.3 Examinations and tests described in 6.1.11 for electronic instruments shall be performed.

6.1.8 Pattern approval of a conversion device

6.1.8.1 General case

It is necessary to verify whether the conversion device connected to all its associated measuring instruments complies with provisions in 2.7.1. For that purpose, the volume at metering conditions which is converted is supposed to be without any error.

It may also be verified that the provisions in 2.7.4 (and 2.7.5 if applicable) are fulfilled.

In the case of an electronic conversion device, the tests and examination described in 6.1.11 shall be performed.

6.1.8.2 Electronic conversion device

Instead of the procedure in 6.1.8.1, it is also possible

- to verify separately the accuracy of associated measuring instruments (see 2.7.2);
- to verify that the provisions in 6.1.7.2 are fulfilled; and
- to perform examinations and tests described in 6.1.11.

6.1.9 Pattern approval of an ancillary device

6.1.9.1 When an ancillary device that provides primary indications is intended to be approved separately, its indications shall be compared with those provided by an indicating device that has already be approved and which has the same scale interval, or a smaller one.

The results shall satisfy the provisions in 2.9.5.

As far as possible, the necessary conditions for compatibility with other devices of a measuring system are stated in the pattern approval certificate.

6.1.9.2 Electronic devices may be approved separately when they are used for the transmission of primary indications or other information necessary for their determination, e.g. a device which concentrates information from two or more calculators and transmits it to a single printing device.

When at least one of the signals of this information is analogue, the device shall be tested in association with another device whose maximum permissible errors are provided by this document.

When all the signals of this information are digital, the above provision may be applied; however, when the inputs and outputs of the device are available, the device can be tested separately, in which case it shall introduce no error; only errors due to the testing method may be found out.

In both cases and as far as possible, the necessary conditions for compatibility with other devices of a measuring system are stated in the pattern approval certificate.

6.1.10 Pattern approval of a measuring system

The pattern approval of a measuring system consists of verifying that the constituent elements of the system, which have not been subject to separate pattern approvals, satisfy the applicable requirements, and that these constituent elements are compatible with one another.

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

When none of the constituent elements has been subject to separate pattern approval, all the tests provided for in 6.1.5, 6.1.6 and 6.1.7 (in particular) shall be performed on the complete measuring system. On the contrary, when the various constituent elements are all approved separately, it is possible to replace pattern approval based on tests by pattern approval of drawings.

It is also appropriate to reduce the pattern evaluation program when the measuring system includes constituent elements identical to those which equip another measuring system that has already been approved, and when the operating conditions of these elements are identical. For example, it is not necessary to perform the expansion test of a hose in a fuel dispenser when the hose in this measuring system is identical to the hose equipping another measuring system already approved with the same minimum measured quantity.

Note: It is advisable that constituent elements be subject to separate pattern approval when they are intended to equip several patterns of measuring systems. This is particularly advisable when the various measuring systems have different manufacturers.

6.1.11 Pattern approval of an electronic device

In addition to the examinations or tests described in the preceding paragraphs, an electronic measuring system or an electronic constituent element of this system shall be subject to the following tests and examinations.

6.1.11.1 Design inspection

This examination of documents aims at verifying that the design of electronic devices and their checking facilities comply with the provisions of this document, 4 in particular.

It includes:

(a) an examination of the mode of construction and of the electronic sub-systems and components used, to verify their appropriateness for their intended use;

(b) consideration of faults likely to occur, to verify that in all considered cases these devices comply with the provisions of 4.3; and

(c) verification of the presence and effectiveness of the test device(s) for the checking facilities.

6.1.11.2 Performance tests

These tests aim at verifying that the measuring system complies with the provisions of 4.1.1 with regard to influence quantities. These tests are specified in Annex A.

(a) Performance under the effect of influence factors

When subjected to the effect of influence factors as provided for in Annex A, the equipment shall continue to operate correctly and the errors shall not exceed the applicable maximum permissible errors.

(b) Performance under the effect of disturbances

When subjected to external disturbances as provided for in Annex A, the equipment shall either continue to operate correctly or detect and indicate the presence of any significant faults. Significant faults shall not occur on non-interruptible measuring systems.

6.1.11.3 Equipment under test (EUT)

Tests are carried out on the complete measuring system where size and configuration permit, except where otherwise specified in Annex A.

Where tests are not carried out on a complete system, they shall be carried out on a sub-system comprising at least the following devices:

- measuring transducer;
- calculator;
- indicating device;
- power supply device; and
- correction device, if appropriate.

This sub-system shall be included in a simulation set-up representative of the normal operation of the measuring system. For example, the movement of the liquid may be simulated by an appropriate device.

The calculator shall be in its final housing.

In all cases, peripheral equipment may be tested separately.

6.2 Initial Verification

6.2.1 General

Initial verification of a measuring system is carried out in a single stage when the system can be transported without dismantling and when it is verified under the intended conditions of use; in all other cases, it is carried out in two stages.

The first stage concerns at least the measurement transducer, alone or fitted with associated ancillary devices, or possibly included in a sub-system. Tests of the first stage may be carried out on a test bench, possibly in the factory of the manufacturer, or on the installed measuring system. At this stage, the metrological examinations may be carried out with different liquids than those which the system is intended to measure.

The first stage also concerns the calculator and the density sensor. If necessary, the measurement transducer and the calculator can be verified separately.

The second stage concerns the measuring system in actual working condition. It is carried out at the place of installation under operating conditions and with the intended liquid of use. However, the second stage may be carried out in a place chosen by the verification body when the measuring system can be transported without dismantling and when the tests can be performed under the operating conditions intended for the measuring system.

Initial verification of electronic systems shall include a procedure for verifying the presence and correct operation of checking facilities by the use of test devices as specified in 4.3.

6.2.2 Tests

6.2.2.1 When initial verification takes place in two stages, the first stage shall include:

- an examination for conformity of the meter, including the associated ancillary devices (conformity with the respective patterns);
- a metrological examination of the meter, including the associated ancillary devices.

The second stage shall include:

- an examination for conformity of the measuring system, including the meter and the ancillary and additional devices;
- a metrological examination of the measuring system; if possible, this examination is carried out within the limits of operating conditions for the system;

- an operational test of the gas elimination device, where appropriate, with no need to verify that the maximum errors applicable to this device and specified in 2.10 are met;
- an inspection of the adjustment of the prescribed pressure maintaining devices where appropriate;
- when necessary, a test of the variations of the internal volume of the hoses in full hose measuring systems, e.g. in the case of a hose reel;
- an operational test of the control valve preventing the emptying of the hose during non-operating periods, for full hose measuring systems;
- a determination of the residual quantities in empty hose measuring systems.

6.2.2.2 When initial verification takes place in one stage, all tests in 6.2.2.1 shall be performed.

6.3 Subsequent Verification

6.3.1 Subsequent verification of a measuring system may be identical to initial verification.

6.3.2 The preliminary examination of the meter should only be repeated if the protective marks on the measuring element of the meter have been damaged. This examination may be replaced by a test of the measuring system if the conditions for the preliminary examination are met and if the measuring system can undergo testing with a volume of liquid corresponding to the minimum measured quantity. For the determination of the error curve, at least 60% of the maximum flow rate should be reached.

6.3.3 The ancillary devices shall be considered as having been subjected to the preliminary examination if the protective marks are not damaged. It is sufficient to carry out a reduced number of measurements during the simplified examination of the ancillary devices.

ANNEX A.
PERFORMANCE TESTS FOR ELECTRONIC MEASURING SYSTEMS (MANDATORY)

A.1 General

This Annex defines the program of performance tests intended to verify that electronic measuring systems may perform and function as intended in a specified environment and under specified conditions. Each test indicates, where appropriate, the reference conditions for determining the intrinsic error.

These tests supplement any other prescribed test.

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

A.2 Severity Levels

See OIML D 11 (1994).

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

Measuring systems are divided into three classes according to climatic and mechanical environmental conditions:

- class B for fixed instruments installed in a building;
- class C for fixed instruments installed outdoors; and
- class I for mobile instruments, in particular measuring systems on trucks.

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

A.3 Reference Conditions

Ambient temperature: 20°C ± 5°C.
Relative humidity: 60% ± 15%.
Atmospheric pressure: 86 kPa to 106 kPa.
Power voltage: nominal voltage (V_{nom}).
Power frequency: nominal frequency (F_{nom}).
During each test, the temperature and relative humidity shall not vary by more than 5°C or 10% respectively within the reference range.

A.4 Performance Tests

The following tests can be carried out in any order.

Test		Nature of the influence quantity	Severity level for the class (by ref. to OIML D 11)		
			B	C	I
A.4.1	Dry heat	Influence factor	2	3	3
A.4.2	Cold	Influence factor	2	3	3
A.4.3	Damp heat, cyclic	Influence factor	1	2	2
A.4.4	Vibration (sinusoidal)	Influence factor	—	—	3
A.4.5	Power voltage variation	Influence factor	1	1	1
A.4.6	Short time power reductions	Disturbance	1a, 1b	1a, 1b	1a, 1b
A.4.7	Bursts	Disturbance	2	2	2
A.4.8	Electrostatic discharge	Disturbance	1	1	1
A.4.9	Electromagnetic susceptibility	Disturbance	2, 5, 7	2, 5, 7	2, 5, 7
A.4.10	Disturbances on d.c. voltage powered equipment				

The above tests involve the electronic part of the measuring system or its devices.

The following rules shall be taken into consideration for these tests:

(1) Tests volumes

Some influence quantities should have a constant effect on measurement results and not a proportional effect related to the measured volume. The value of the significant fault is related to the measured volume; therefore, in order to be able to compare results obtained in different laboratories, it is necessary to perform a test on a volume corresponding to that delivered in 1 min at the maximum flow rate, but not less than the minimum measured quantity. Some tests, however, may require more than 1 min, in which case they shall be carried out in the shortest possible time.

(2) Influence of the liquid temperature

Temperature tests concern the ambient temperature and not the temperature of the liquid used. It is therefore advisable to use a simulation test method so that the temperature of the liquid does not influence the test results.

A.4.1 Dry heat

Test method

Dry heat (non-condensing).

Object of the test

To verify compliance with the provisions in 4.1.1 under conditions of high temperature.

References

IEC 60068-2-2 (1974). Background information concerning dry heat tests is given in IEC 60068-3-1 (1974) and first supplement 60068-3-1A (1978). General background information on basic environmental testing procedures is given in IEC 60068-1 (1988) which is equivalent to AS 1099.1 (1989).

Test procedure in brief

The test consists of exposure of the EUT to a temperature of 55°C (classes C or I)) or 40°C (class B) under 'free air' conditions for a 2 h period after the EUT has reached temperature stability. The EUT shall be tested at least one flow rate (or simulated flow rate):

- at the reference temperature of 20°C following conditioning;
- at the temperature of 55°C or 40°C, 2 h after temperature stabilisation; and
- after recovery of the EUT at the reference temperature of 20°C.

Note: This test procedure is in condensed form, for information only, and is adapted from the referenced publications. Before conducting the test these publications should be consulted.

Test severities

(1) Temperature: severity level 2: 40°C and severity level 3: 55°C.
(2) Duration: 2 h.

Number of test cycles

One cycle.

Maximum allowable variations

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

A.4.2 Cold

Test method

Cold.

Object of the test

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

References

IEC 60068-2-1 (1990). Background information concerning cold tests is given in IEC 60068-3-1 (1974) and first supplement 60068-3-1A (1978). General background information on basic environmental testing procedures is given in IEC 60068-1 (1988) which is equivalent to AS 1099.1 (1989).

Test procedure in brief

The test consists of exposure of EUT to a temperature of –25°C (classes C or I) or –10°C (class B) under 'free air' conditions for a 2 h period after the EUT has reached temperature stability. The EUT shall be tested at least one flow rate (or simulated flow rate):

- at the reference temperature of 20°C following conditioning;
- at a temperature of –25°C or –10°C, 2 h after temperature stabilisation; and
- after recovery of the EUT at the reference temperature of 20°C.

Note: This test procedure is in condensed form, for information only, and is adapted from the referenced publications. Before conducting the test these publications should be consulted.

Test severities

(1) Temperature: severity level 2: –10°C and severity level 3: –25°C.
(2) Duration: 2 h.

Number of test cycles

One cycle.

Maximum allowable variations

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

A.4.3 Damp heat, cyclic

Test method

Damp heat, cyclic (condensing).

Object of the test

To verify compliance with the provisions in 4.1.1 under conditions of high humidity when combined with cyclic temperature changes.

References

IEC 60068-2-30 (1980). Background information concerning damp heat tests is given in IEC 60068-3-4 (2001).

Test procedure in brief

The test consists of exposure of the EUT to cyclic temperature variations between, 25°C and the upper temperature of 55°C (classes C or I) or 40°C (class B), maintaining the relative humidity above 95% during the temperature changes and during the phases at low temperature, and at 93% at the upper temperature phases. Condensation should occur on the EUT during the temperature rise. Standard stabilising period before and recovery after the cyclic exposure are indicated in IEC 60068-2-30 (1980).

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

Note: This test procedure is in condensed form, for information only, and is adapted from the referenced publications. Before conducting the test these publications should be consulted.

Test severities

(1) Upper temperature: severity level 1: 40°C and severity level 2: 55°C.
(2) Humidity: > 93%.
(3) Duration: 24 h.

Number of test cycles

Two cycles.

Maximum allowable variations

After the application of the influence factor and recovery:

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

A.4.4 Vibration

Test method

Sinusoidal vibration.

Object of the test

To verify compliance with the provisions in 4.1.1 under conditions of sinusoidal vibration. This test should normally apply to mobile measuring systems only.

Reference

IEC 60068-2-6 (1995).

Test procedure in brief

The EUT shall be tested by sweeping the frequency in the specified frequency range, at 1 octave/minute, at the specified acceleration level with a specified number of sweep cycles per axis. The EUT shall be tested in its three, mutually perpendicular main axes, mounted on a rigid fixture by its normal mounting means. It shall normally be mounted so that the gravitational force acts in the same direction as it would in normal use.

The instrument is non-operational when the influence factor is applied.

Note: This test procedure is in condensed form, for information only, and is adapted from the referenced publication. Before conducting the test the publication should be consulted.

Test severities

(1) Frequency range: 10 to 150 Hz.
(2) Maximum acceleration level: 20 m s^{-2}.

Number of test cycles

20 sweep cycles per axis.

Maximum allowable variations

After the application of the influence factor and recovery:

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

A.4.5 Power voltage variation

Test method

Variation in a.c. mains power supply (single phase).

Object of the test

To verify compliance with the provisions in 4.1.1 under conditions of varying a.c. mains power supply.

References

No reference to an international standard can be given at the present time.

Test procedure in brief

The test consists of exposure of the EUT to power voltage variations, while the EUT is operating under normal atmospheric conditions.

Test severities

Mains voltage: upper limit: V_{nom} + 10% and lower limit: V_{nom} – 15%.

Number of test cycles

One cycle.

Maximum allowable variations

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

A.4.6 Short time power reduction

Test method

Short time interruptions and reductions in mains voltage.

Object of the test

To verify compliance with the provisions in 4.1.1 under conditions of short time mains voltage interruptions and reductions.

References

No reference to international standard can be given at the present time.

Test procedure in brief

The test consists of subjecting the EUT to voltage interruptions from nominal voltage to zero voltage for a duration equal to half a cycle of line frequency, and reductions from nominal voltage to 50% of nominal for a duration equal to one cycle of line frequency. The mains voltage interruptions and reductions shall be repeated ten times with a time interval of at least 10 s.

Test severities

100% voltage interruption for a period equal to half a cycle. 50% voltage reduction for a period equal to one cycle.

Number of test cycles

At least ten interruptions and ten reductions, each with a minimum of 10 s between tests.

The interruptions and reductions are repeated throughout the time necessary to perform the whole test; for this reason, more than ten interruptions and reductions may be necessary.

Maximum allowable variations

(a) For interruptible measuring systems, either the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in T.3.12 or the measuring system shall detect and act upon a significant fault, in compliance with 4.3.1.

(b) For non-interruptible measuring systems, the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in T.3.12.

A.4.7 Bursts

Test method

Electrical bursts.

Object of the test

To verify compliance with the provisions in 4.1.1 under conditions where electrical bursts are superimposed on the mains voltage.

Reference

IEC 61000-4-4 (1995).

Test procedure in brief

The test consists of subjecting the EUT to bursts of double exponential waveform transient voltages. Each spike shall have a rise time of 5 ns and a half amplitude duration of 50 ns. The burst length shall be 15 ms, the burst period (repetition time interval) shall be 300 ms. All bursts shall be applied during the same measurement or simulated measurement in

symmetrical mode and asymmetrical mode.

Note: This test procedure is in condensed form, for information only, and is adapted from the referenced publication. Before conducting the test the publication should be consulted.

Test severities

Amplitude (peak value) 1 000 V.

Number of test cycles

At least ten positive and ten negative randomly phased bursts shall be applied at 1 000 V.

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

Maximum allowable variations

(a) For interruptible measuring systems, either the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in T.3.12 or the measuring system shall detect and act upon a significant fault, in compliance with 4.3.1.

(b) For non-interruptible measuring systems, the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in T.3.12.

A.4.8 Electrostatic discharge

Test method

Electrostatic discharge (ESD).

Object of the test

To verify compliance with the provisions in 4.1.1 under conditions of direct and indirect electrostatic discharges.

Reference

IEC 61000-4-2 (2001).

Test procedure in brief

A capacitor of 150 pF is charged by a suitable DC voltage source. The capacitor is then discharged through the EUT by connecting one terminal to ground (chassis) and the other via 330 Ω to surfaces which are normally accessible to the operator.

The test includes the paint penetration method, if appropriate. For direct discharges the air discharge shall be used where the contact discharge method cannot be applied.

Note: This test procedure is in condensed form, for information only, and is adapted from the referenced publication. Before conducting the test the publication should be consulted.

Test severities

8 kV for air discharges and 6 kV for contact discharges.

Number of test cycles

At each test point, at least ten direct discharges shall be applied at intervals of at least 10 s between discharges, during the same measurement or simulated measurement. As for indirect discharges, a total of ten discharges shall be applied on the horizontal coupling plane, and a total of ten discharges for the various positions of the vertical coupling plane.

Maximum allowable variations

(a) For interruptible measuring systems, either the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in T.3.12 or the measuring system shall detect and act upon a significant fault, in compliance with 4.3.1.

(b) For non-interruptible measuring systems, the difference between the volume indication during the test and the indication under reference conditions shall not exceed the values given in T.3.12.

A.4.9 Electromagnetic susceptibility

Test method

Electromagnetic fields (radiated).

Object of the test

To verify compliance with the provisions in 4.1.1 under conditions of electromagnetic fields.

Reference

IEC 61000-4-3 (2002).

Test procedure in brief

The EUT shall be exposed to electromagnetic field strength as specified by the severity level.

The field strength can be generated using dipole antennas or antennas with circular polarisation placed 1 m from the EUT at high frequencies.

The specified field strength shall be established prior to the actual testing (without EUT in the field).

The field shall be generated in two orthogonal polarisations and the frequency range shall be scanned slowly. If antennas with circular polarisation, i.e. log-spiral or helical antennas are used to generate the electromagnetic field, a change in the position of the antennas is not required.

When the test is carried out in a shielded enclosure to comply with international laws prohibiting interference to radio communications, care should be taken to handle reflections from the walls. Anechoic shielding may be necessary.

Note: This test procedure is in condensed form, for information only, and is adapted from the referenced publication. Before conducting the test the publication should be consulted.

The tests shall be carried out for the following conditions:

The voltage and auxiliary circuits energised with reference voltage;

(a) Without any current in the current circuits and the current terminals shall be open circuit;

(b) With basic current I_b resp. rated current I_n and power factor equal to 1.

Test severities

Frequency range Field strength	80 to 1000 MHz 10 V/m
Modulation	80% AM, 1 kHz sine wave

Maximum allowable variations

(a) Without any current in the current circuits the application of the electromagnetic field shall not produce a change in the register of the meter of more than x kWh and the test output shall not produce a signal more equivalent to more than x kWh, where the formula x is given in

(b) With basic current I_b resp. rated current I_n and power factor equal to 1, at sensitive frequencies or frequencies of dominant interest, the variation of error shall be within the limits given in table 2.

A.4.10 Disturbances on dc voltage powered instruments

Electronic measuring systems supplied with dc voltage shall fulfil the tests in A.4.1 to A.4.9, with the exception of A.4.5, A.4.6 and A.4.7 which are to be replaced by the following provisions.

General provision

For under-voltages or over-voltages all errors shall be within maximum permissible errors when the instrument is still operating.

The under-voltage or over-voltage is applied for a complete measurement or part of a measurement.

Provision applicable to instruments fed by the battery of a vehicle

Tests pulses 1, 2 and 3 of the relevant part of ISO 7637-1 (1984) and ISO 7637-2 (1990) are applied at the various severity levels specified in this standard.

Pulses are repeated for as long as necessary to complete the test.

The pattern approval certificate shall indicate, for each type of pulse, the maximum severity level met by the instrument.

ANNEX B.
TESTING OF GAS ELIMINATION DEVICES (INFORMATIVE)

This Annex, developed by a joint ISO-OIML working group, concerns 6.1.6. The following tests are recommended.

B.1 Testing of a Gas Elimination Device as a Unit Separate from the Measuring System for which it is Intended

B.1.1 General provisions

In order to examine whether the pattern of a gas elimination device complies with the requirements in 2.10, a specimen of the pattern must be installed on a suitable test bench equipped with a meter and a conventional proving tank.

Note: In tests on gas elimination devices, the proving tank may be replaced by any appropriate standard.

The efficiency of the gas elimination device is determined with reference to the meter error at the same flow rate.

The test bench must, as far as possible, comply with the following provisions:

- the capacity of the proving tank should be at least equal to the greater of the following two values: volume delivered in 1 min at maximum flow rate, or 1 000 times the scale interval of the meter on the test bench;
- it is recommended that an adjustable non-return valve be installed downstream of the meter in order to prevent back flow of the liquid which has been measured and to obtain the minimum back pressure required for the proper operation of the gas elimination device;
- there should be no reverse gradient in the pipework downstream of the meter so that gas bubbles are allowed to escape in the normal way in order to keep this pipework filled to the same level at the beginning and end of the test;
- the liquid used for the tests should either be the same as that for which the device is intended or should be of a viscosity which is at least equal to that of the liquid for which it is intended.

Tests on gas elimination devices should be carried out for flow rates up to a maximum of 100 m^3/h. For higher flow rates, characteristics may be determined by analogy with equipment of the same design and smaller dimensions. ‘By analogy’ means that parameters like Reynolds number, Froude number, etc. are to be taken into account for the gas elimination device.

B.1.2 Tests on gas separators

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

A pressure gauge positioned upstream of the meter for liquid makes it possible to determine the lowest pressure at which the gas separator still meets the efficiency requirements.

Before starting a test, the whole apparatus is made to operate at the desired liquid and gas flow rates so that all parts of the apparatus (except the proving tank) fill up under set conditions as regards the entry of air or gas.

The air may be introduced either by injection downstream of the pump or by suction upstream of it (see Figures 1, 2 and 3, which are given as examples).

In the former case, which makes it possible to operate without changing the performance of the pump due to the entry of air, the liquid and gas flows are adjusted by means of control valves. The air or gas is introduced through a tube positioned in the centre of the pipework for the liquid, for example at an elbow.

In the latter case, which reproduces the conditions encountered in reality (pressure reduction by suction), the pump must be set to the maximum flow rate of the separator. If the pump has too great a flow rate, it must be possible to regulate it with a speed reducer. The pump should preferably be of the volumetric type but it may also be of the centrifugal type if the supply tank feeds the pump by gravity. The pressure reduction must then be regulated by a valve positioned upstream of the pump, and the air inlet must be equipped with a non-return valve which prevents any leakage at the moment of switching off.

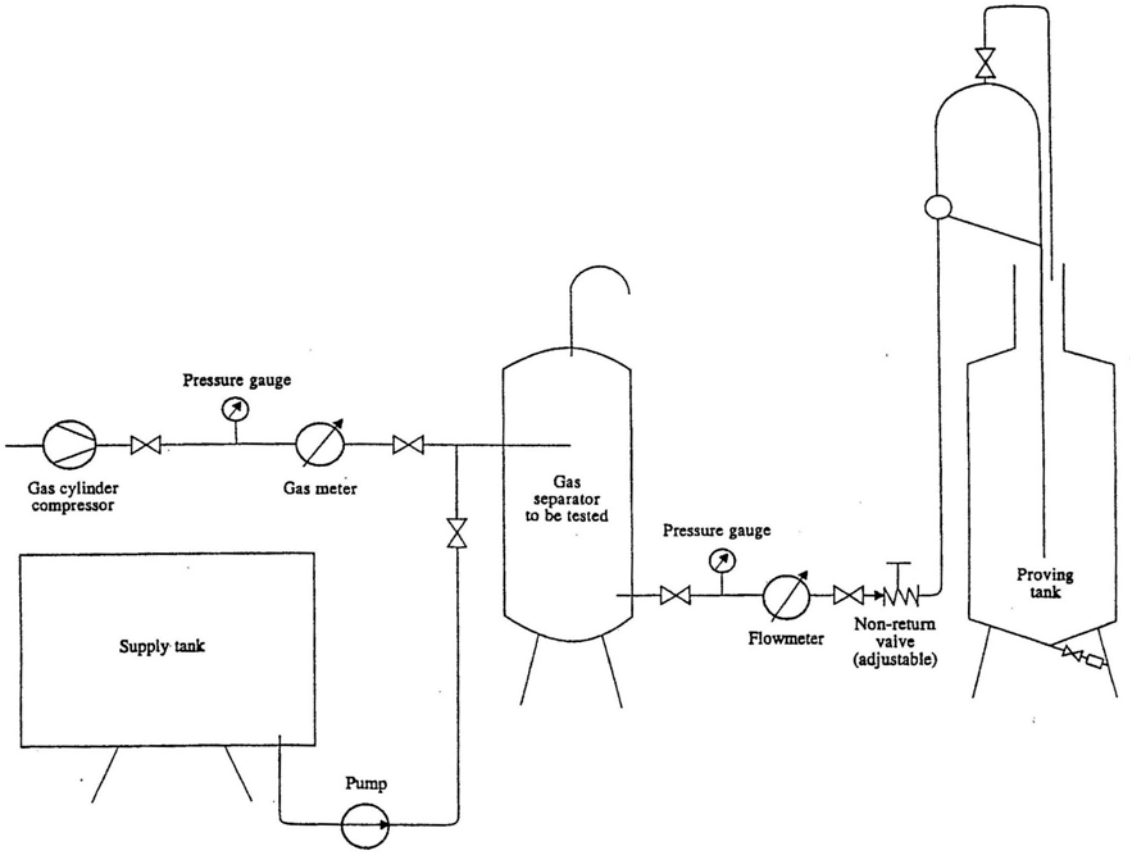


Figure 1. Test bench for gas separators

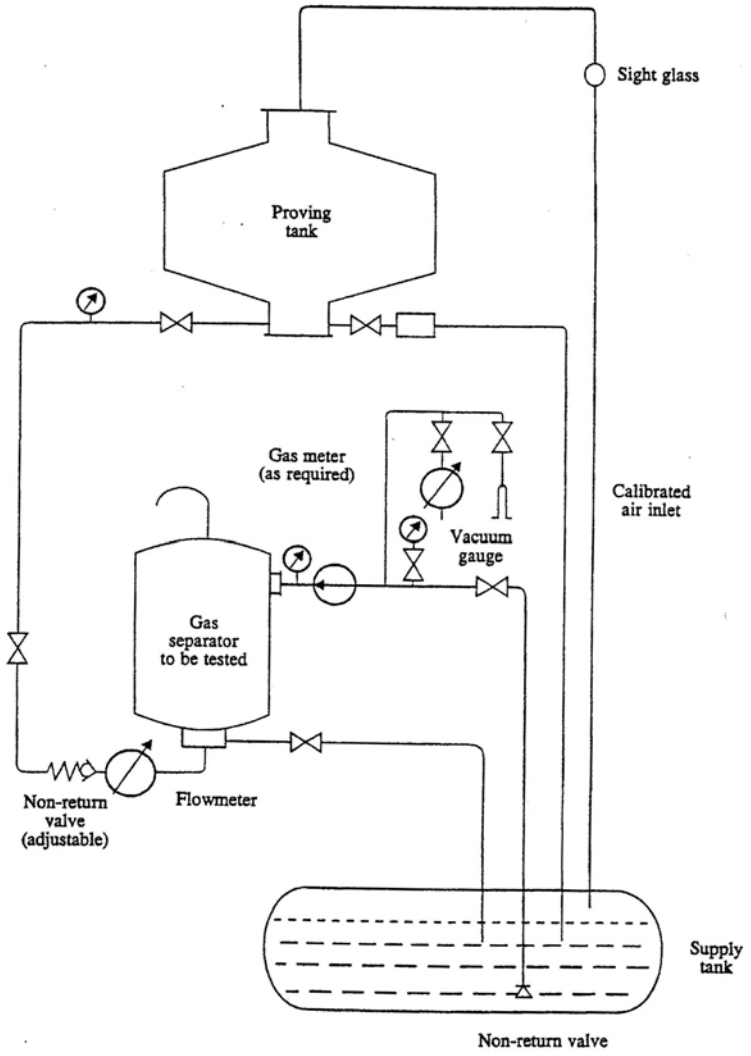


Figure 2. Test bench for gas separators

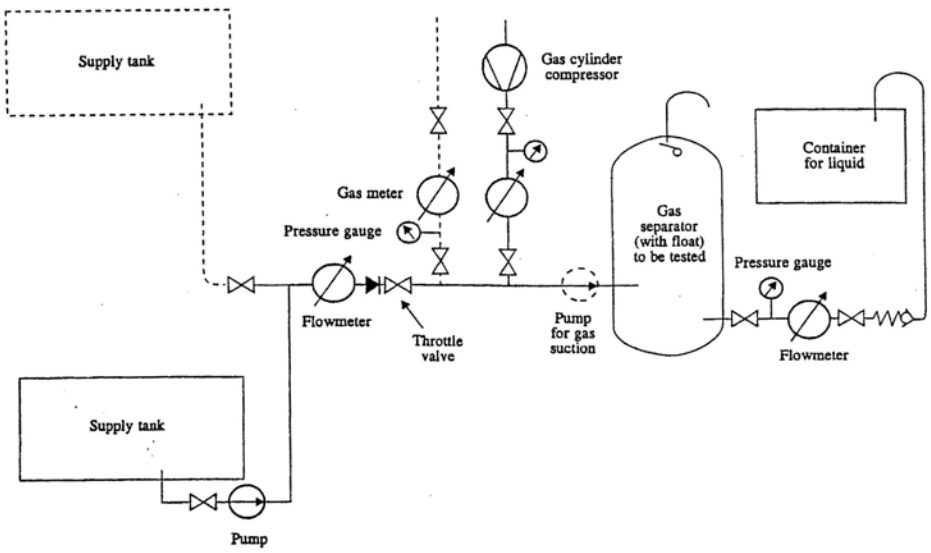


Figure 3. Test bench for gas separators (—— with gas injection, – – –with gas suction)

B.1.3 Test on gas extractors

An example of test bench is shown in Figure 4.

It includes a container for creating a pocket of air to be removed with a volume equal to the minimum measured quantity of the gas extractor (the minimum measured quantity of the system being not yet specified). When the test is carried out with a proving tank having such a great capacity that the maximum permissible error cannot be evaluated correctly on the basis of a single operation of the gas extractor, the number of operations during the same test shall be multiplied by 2, 3 or 4, to obtain the required accuracy.

B.1.4 Tests on special gas extractors

Special gas extractors, mainly used for measuring systems on road tankers, are principally intended to prevent measurement errors which may arise from the complete emptying of one compartment. They must also separate and continuously remove introduced air, although to a lesser degree than a gas separator.

In the case of separate approval, they should be tested on a test bench which corresponds in principle to Figure 5.

This test bench is similar to that in Figure 1 but it differs in order to reproduce the actual conditions of delivery from road tankers to underground tanks, as is the case when service stations are supplied with petrol, and domestic fuel oil deliveries are made. Thus, the supply tank is located above the special gas extractor and the meter, i.e. at a level corresponding to that of road tanker, and the proving tank is approximately 4 m below the meter.

In order to determine the additional error arising from the complete emptying of a road tanker, which may be caused by the air drawn in at the end of the delivery by the formation of a vortex, the supply tank is filled with a volume of liquid equivalent to that of the proving tank. The liquid is then emptied through the meter into the proving tank without operating the shutoff valve.

For delivery by gravity, pipework is used which bypasses the pump.

Due to the existence of the automatic shutoff valve in the hydraulic circuit connected to the gas extractor, the pocket of air to be evacuated (described in B.1.3) may be created by emptying the pipework between the tank and the gas extractor.

Furthermore, given that a special elimination device should also perform the function of a separator for a small percentage of air introduced continuously (see 2.10.9), it is necessary to carry out this test in a manner comparable to the tests described for separators in B.1.2, with air being either injected into the supply pipework or drawn in upstream of the pump by creating an entry of air and partly closing the valve of the supply tank.

B.2 Tests on Gas Elimination Devices Forming Part of a Measuring System During Pattern Approval

The tests are carried out with a proving tank of the capacity specified in B.1.1, or any appropriate standard.

B.2.1 Tests on a gas separator

This examination particularly applies to patterns of separators included in measuring systems which can be mass produced and transported without dismantling, such as petrol pumps fed by their own supply pumps.

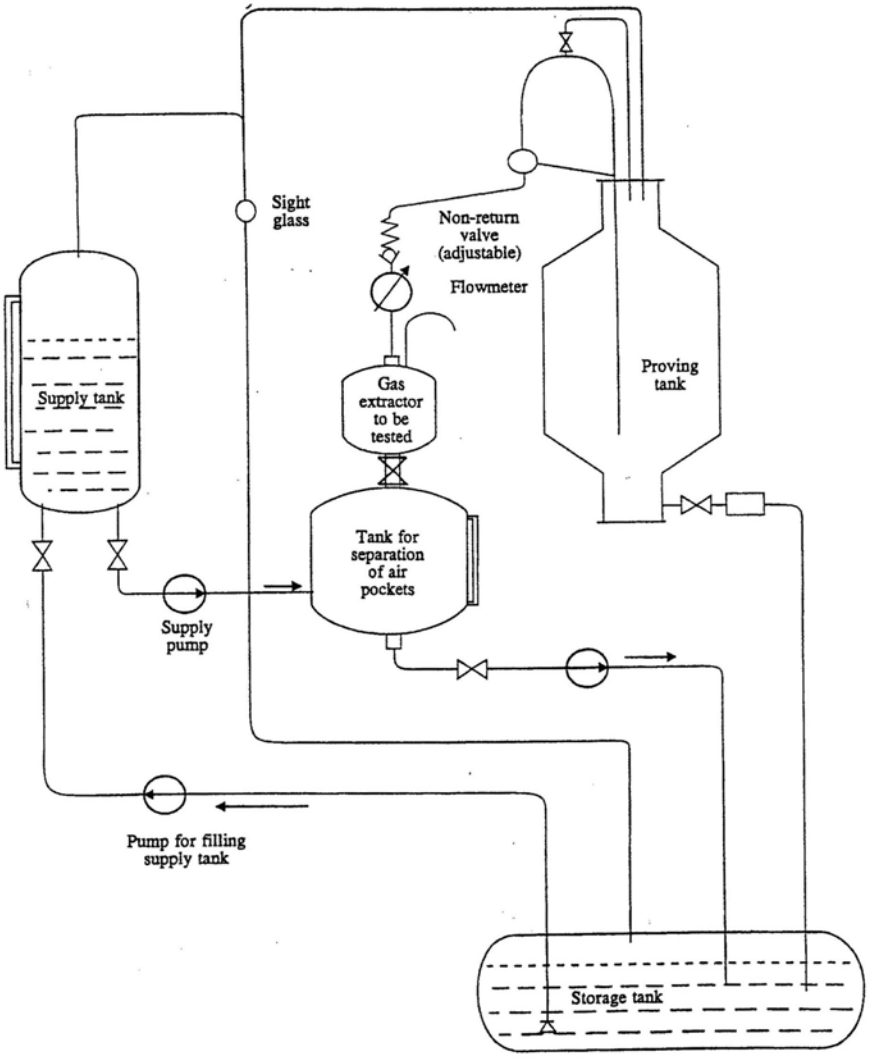


Figure 4. Test bench for gas extractors

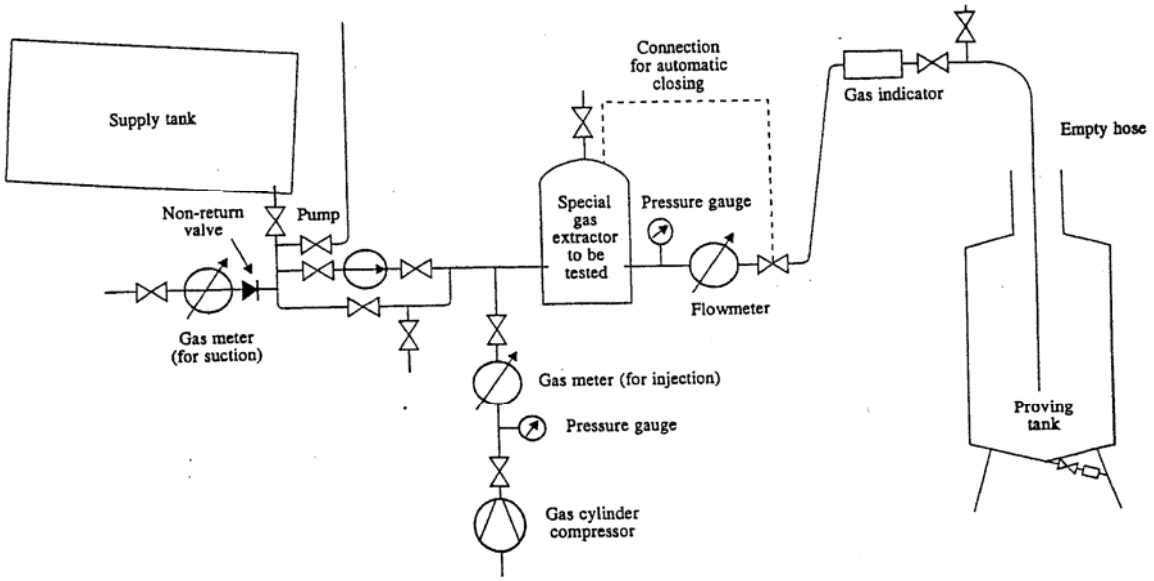


Figure 5. Test bench for special gas extractors

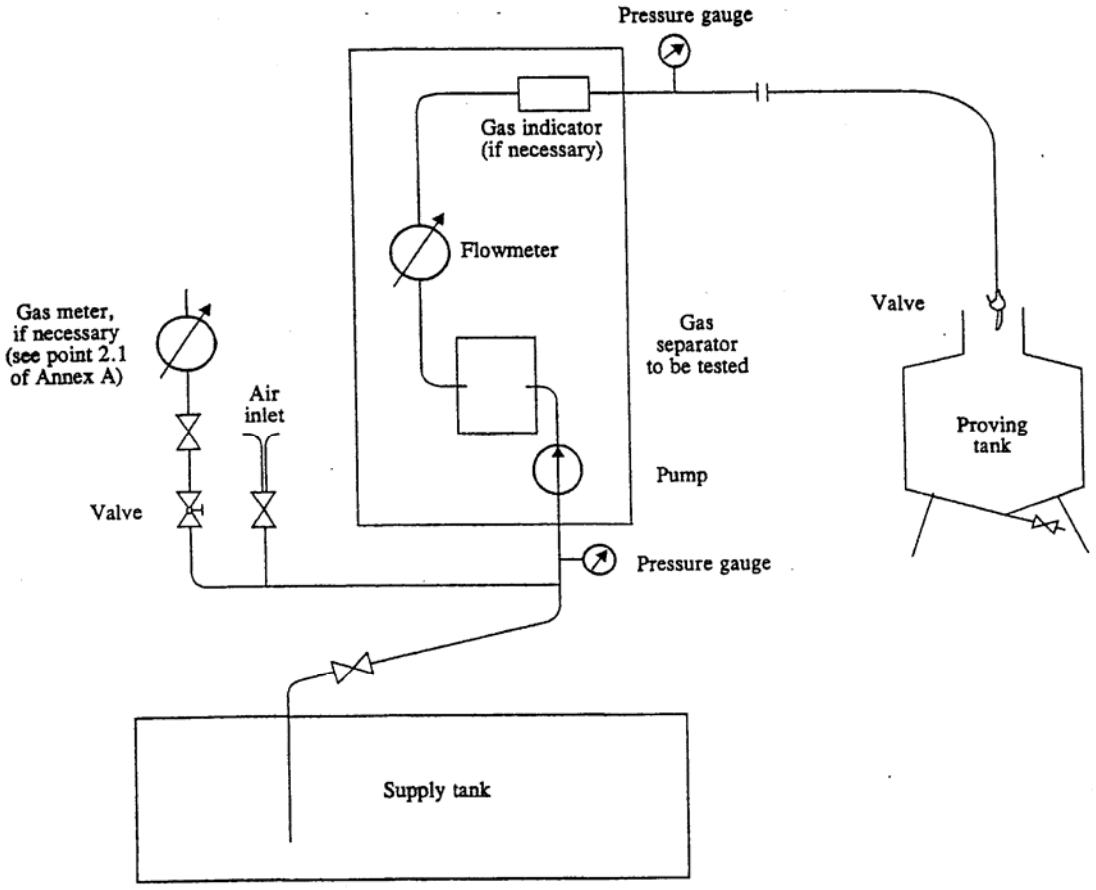


Figure 6. Testing facility for gas separators in fuel dispensers

The essential part of the test bench (Figure 6) is the measuring system itself (in this case, the fuel dispenser).

In accordance with conditions encountered in actual use, the liquid is drawn up from a tank on a lower level than the meter. The air is drawn in by suction through a special inlet equipped with a control valve. The air can be measured by a gas meter. However, it is not necessary to use a gas meter if the separator is capable of separating and eliminating the air introduced in any proportion, as provided in 2.10.8.

The requirements in 2.10.1 and 2.10.8 should be complied with under test conditions such that the maximum flow rate of the measuring system is reached when no air enters.

B.2.2 Tests on a gas extractor and a special gas extractor

The measuring system comprising the gas elimination device must be constructed so that the tests can be carried out as described in B.1.3 or B.1.4.

B.3 Tests on Gas Elimination Devices Forming Part of a Measuring System During Verification

The gas elimination devices are tested without it being necessary to verify that the maximum permissible errors for the individual units are complied with.

ANNEX C.
TERMINOLOGY CLASSIFIED BY ALPHABETICAL ORDER AND BY THEME (INFORMATIVE)

C.1 Alphabetical Classification

Absolute error of measurement T.3.2
Aircraft hydrant measuring system T.2.4
Aircraft refuelling tanker measuring system T.2.3
Additional device T.1.6
Adjustment device T.1.9
Ancillary device T.1.5
Associated measuring instruments T.1.10
Attended post-payment (or post-payment) T.2.11
Attended service mode T.2.8
Authorisation of a measuring system T.2.13
Automatic checking facility T.5.5
Base conditions T.1.14
Blend dispenser T.2.5
Calculator T.1.3
Checking facility T.5.4
Condenser tank T.1.19
Conversion device T.1.12
Correction device T.1.11
Cyclic volume T.3.15
Direct selling to the public T.2.14
Disturbance T.4.3
Durability T.3.13
Electronic component T.5.3
Electronic device T.5.1
Electronic sub-assembly T.5.2
Endurance test T.4.7
Fault T.3.12
First element of an indicating device T.3.17
Fuel dispenser T.2.1
Gas extractor T.1.17
Gas indicator T.1.20
Gas separator T.1.16
Indicating device T.1.4
Influence factor T.4.2
Influence quantity T.4.1
Initial intrinsic error T.3.10
Intermittent automatic checking facility (type I) T.5.7
Interruptible and non-interruptible measuring system T.3.14
Intrinsic error T.3.9
Maximum permissible error T.3.4
Measurement transducer T.1.2
Measuring system T.1.7
Measuring system on pipeline T.2.2
Meter for volumes of liquids T.1.1

Metering conditions T.1.13
Minimum measured quantity of a measuring system T.3.5
Minimum specified price deviation T.3.7
Minimum specified volume deviation T.3.6
Non-automatic checking facility (type N) T.5.8
Performance test T.4.6
Periodic variation T.3.16
Permanent automatic checking facility (type P) T.5.6
Power supply device T.5.9
Pre-payment T.2.10
Pre-setting device T.1.8
Primary indication T.3.1
Rated operating conditions T.4.4
Reference conditions T.4.5
Relative error T.3.3
Repeatability error T.3.8
Self-service arrangement T.2.6
Self-service device T.2.7
Sight glass T.1.21
Significant fault T.3.12
Special gas extractor T.1.18
Transfer point T.1.15
Unattended post-payment (or delayed payment) T.2.12
Unattended service mode T.2.9
Uncertainty of the estimation of an error T.4.8

C.2 Classification by Theme

Measuring system and additional devices:

Measuring system T.1.7
Additional device T.1.6
Transfer point T.1.15
Gas separator T.1.16
Gas extractor T.1.17
Special gas extractor T.1.18
Condenser tank T.1.19
Gas indicator T.1.20
Sight glass T.1.21

Meter:

Meter for volumes of liquids T.1.1
Measurement transducer T.1.2
Adjustment device T.1.9
Correction device T.1.11
Calculator T.1.3
Indicating device T.1.4
Power supply device T.5.9
Cyclic volume T.3.15
Periodic variation T.3.16
First element of an indicating device T.3.17

Devices:

Ancillary device T.1.5
Conversion device T.1.12
Associated measuring instruments T.1.10
Pre-setting device T.1.8

Electronic equipment:

Electronic device T.5.1
Electronic sub-assembly T.5.2
Electronic component T.5.3

Characteristics of the measuring system:

Minimum measured quantity of a measuring system T.3.5
Interruptible and non-interruptible measuring system T.3.14
Durability T.3.13
Primary indication T.3.1

Types of measuring systems:

Measuring system on pipeline T.2.2
Fuel dispenser T.2.1
Blend dispenser T.2.5
Aircraft hydrant measuring system T.2.4
Aircraft refuelling tanker measuring system T.2.3

Dispenser s with self-service devices:

Self-service arrangement T.2.6
Self-service device T.2.7
Attended service mode T.2.8
Unattended service mode T.2.9
Pre-payment T.2.10
Attended post-payment (or post-payment) T.2.11
Unattended post-payment (or delayed payment) T.2.12
Authorisation of a measuring system T.2.13
Direct selling to the public T.2.14

Error and minimum deviation:

Absolute error of measurement T.3.2
Relative error T.3.3
Maximum permissible error T.3.4
Minimum specified volume deviation T.3.6
Minimum specified price deviation T.3.7
Repeatability error T.3.8

Intrinsic error, fault:

Intrinsic error T.3.9
Initial intrinsic error T.3.10
Fault T.3.11
Significant fault T.3.12

Influence factor and disturbance:

Influence quantity T.4.1
Influence factor T.4.2
Disturbance T.4.3

Conditions:

Metering conditions T.1.13
Base conditions T.1.14
Rated operating conditions T.4.4
Reference conditions T.4.5

Checking facilities:

Checking facility T.5.4
Automatic checking facility T.5.5
Permanent automatic checking facility (type P) T.5.6
Intermittent automatic checking facility (type I) T.5.7
Non-automatic checking facility (type N) T.5.8

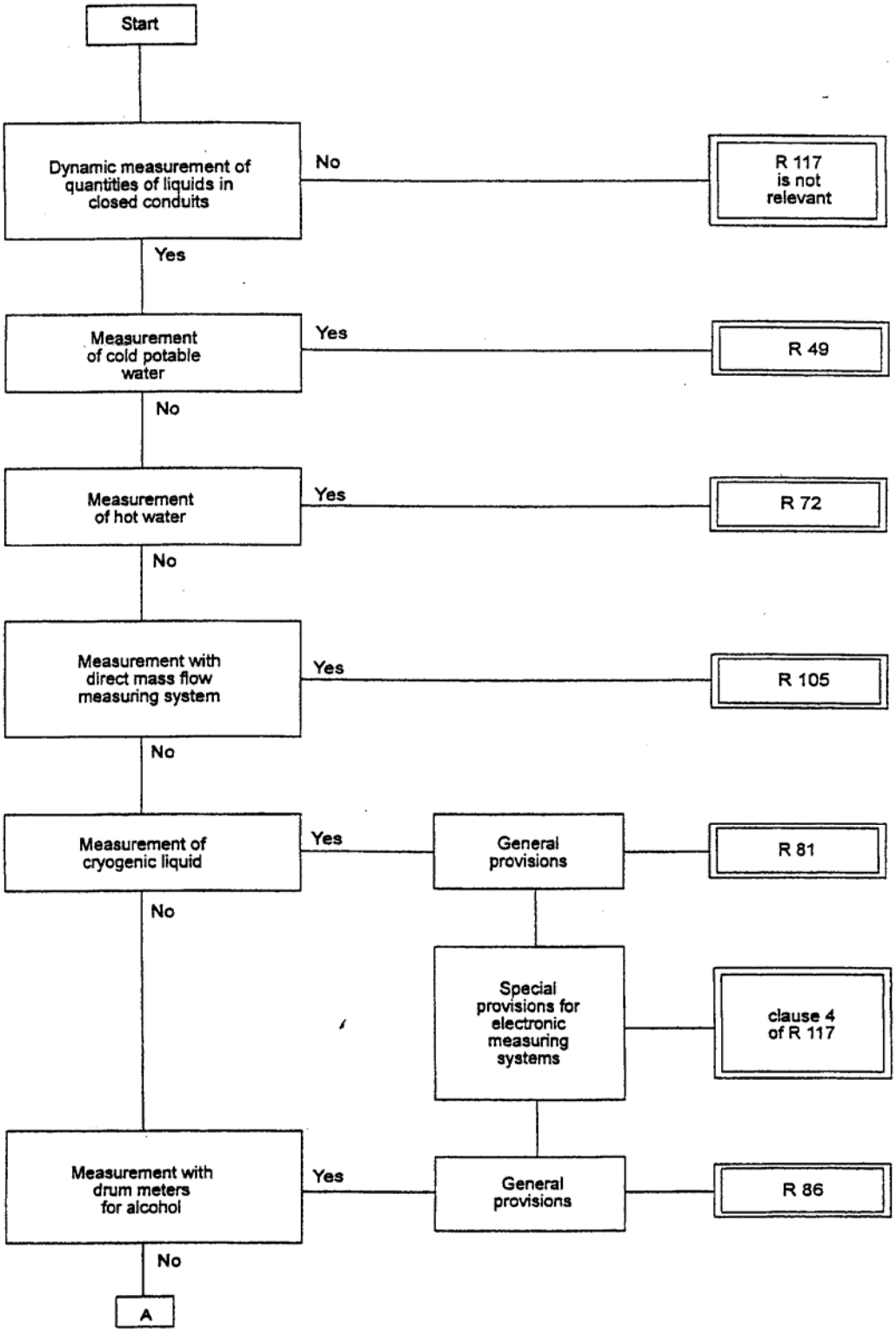
Tests:

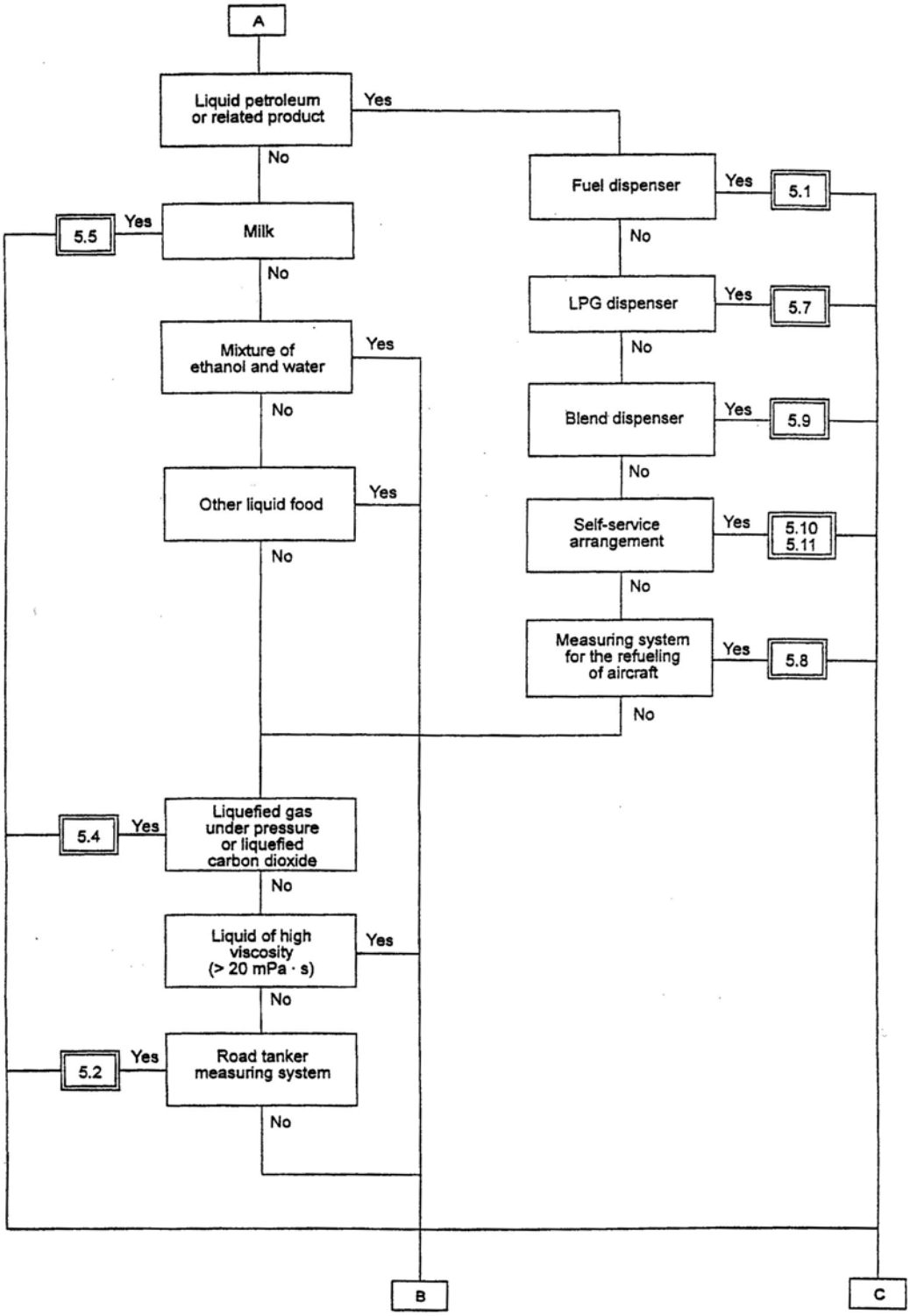
Performance test T.4.6
Endurance test T.4.7
Uncertainty of the determination of an error T.4.8

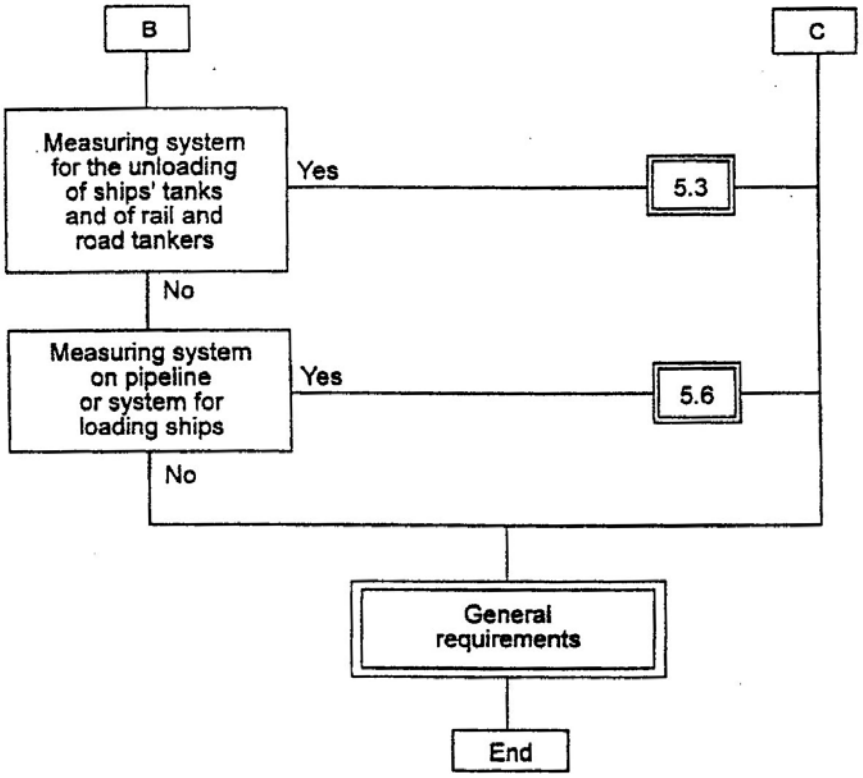
ANNEX D.
GUIDE FOR PATTERN APPROVAL (INFORMATIVE)

Field of Application

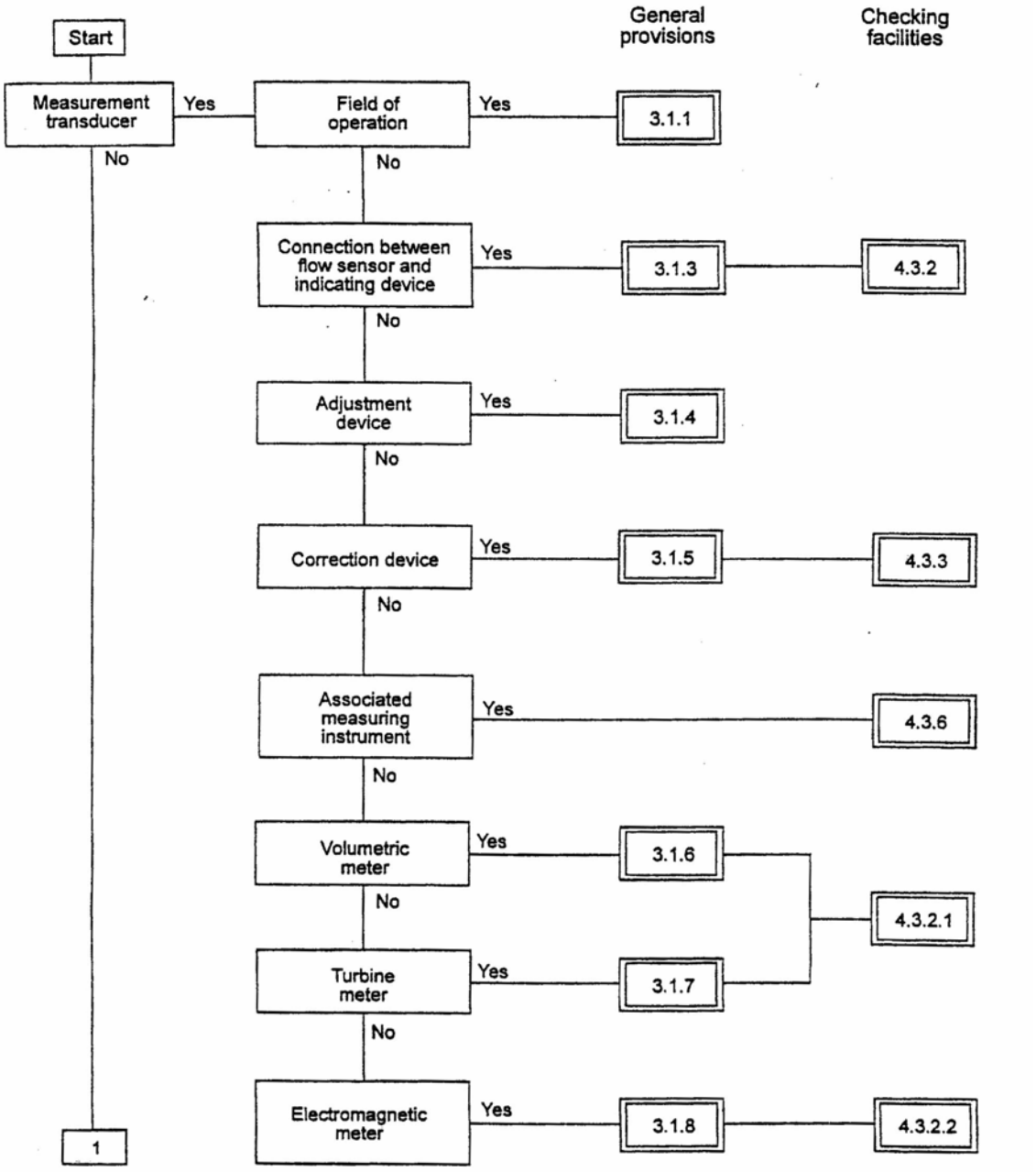
Note: Only direct mass flow measuring systems (NMI R 105) apply.

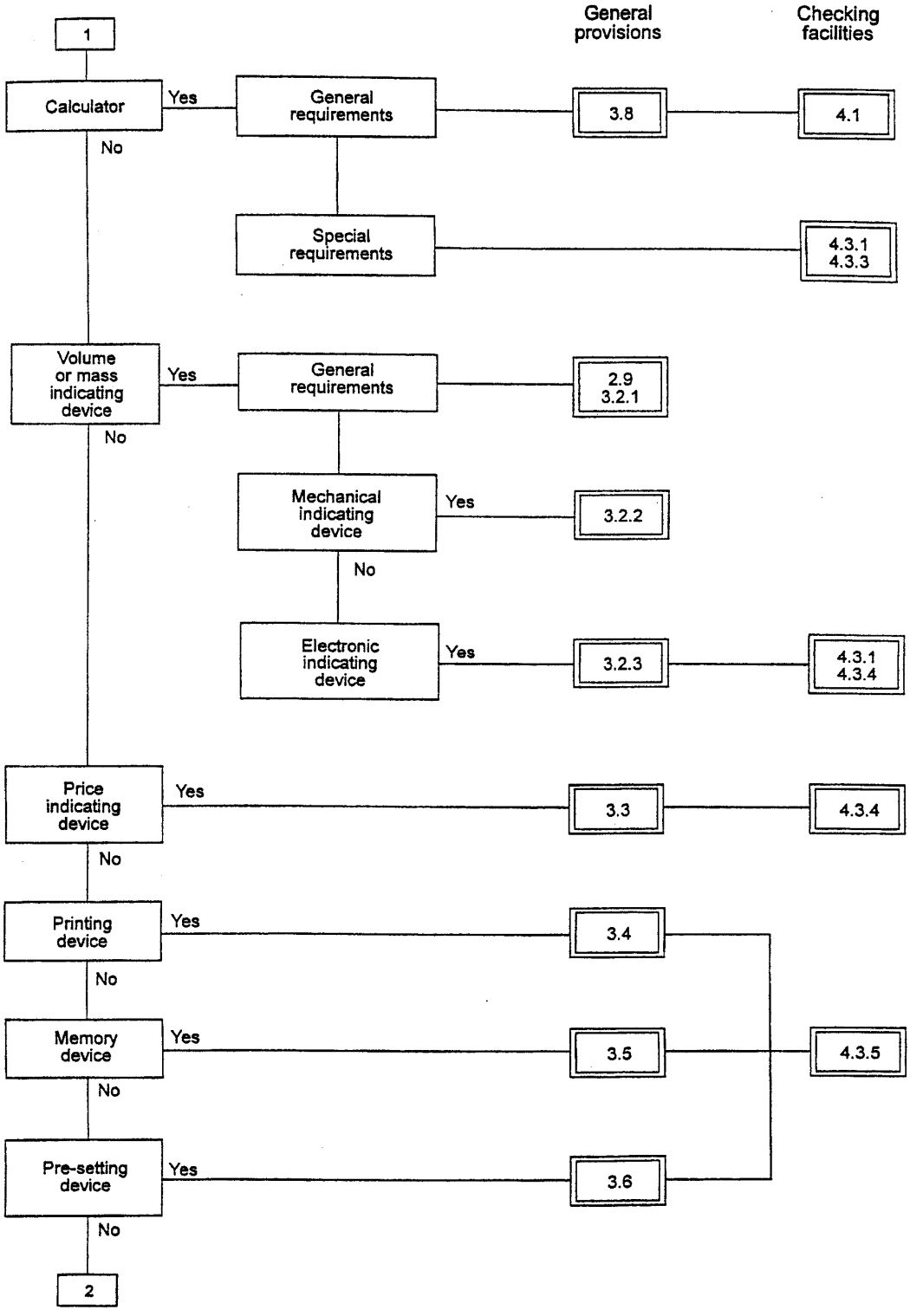


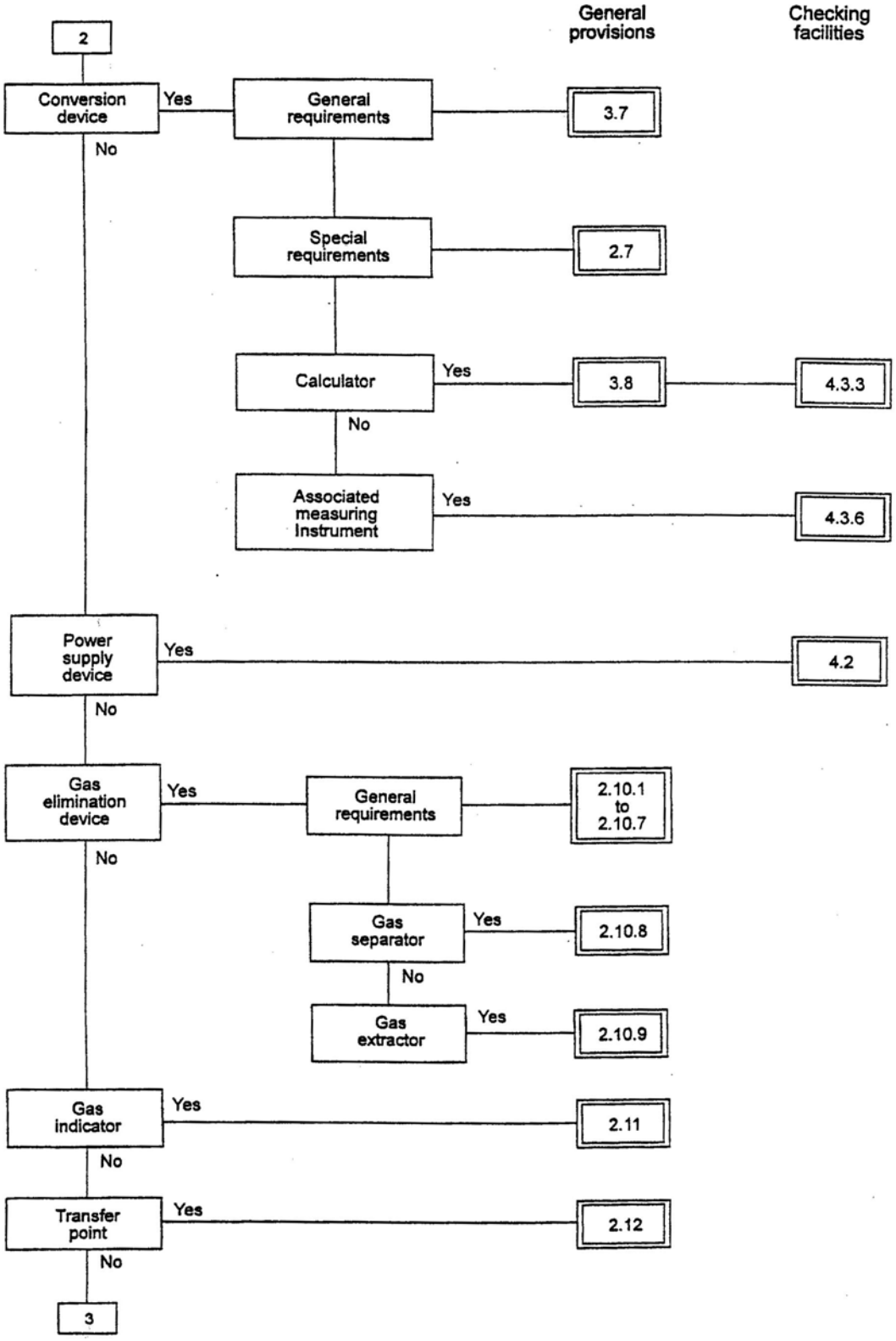

A
Liquid petroleum or related product
Yes
No
Fuel dispenser
Yes
5.1
No
5.5
Yes
Milk
No
LPG dispenser
Yes
5.7
No
Mixture of ethanol and water
Yes
No
Blend dispenser
Yes
5.9
No
Other liquid food
Yes
No
Self-service arrangement
Yes
5.10
5.11
No
Measuring system for the refueling of aircraft
Yes
5.8
No
5.4
Yes
Liquefied gas under pressure or liquefied carbon dioxide
No
Liquid of high viscosity (> 20 mPa · s)
Yes
No
5.2
Yes
Road tanker measuring system
No
B
C

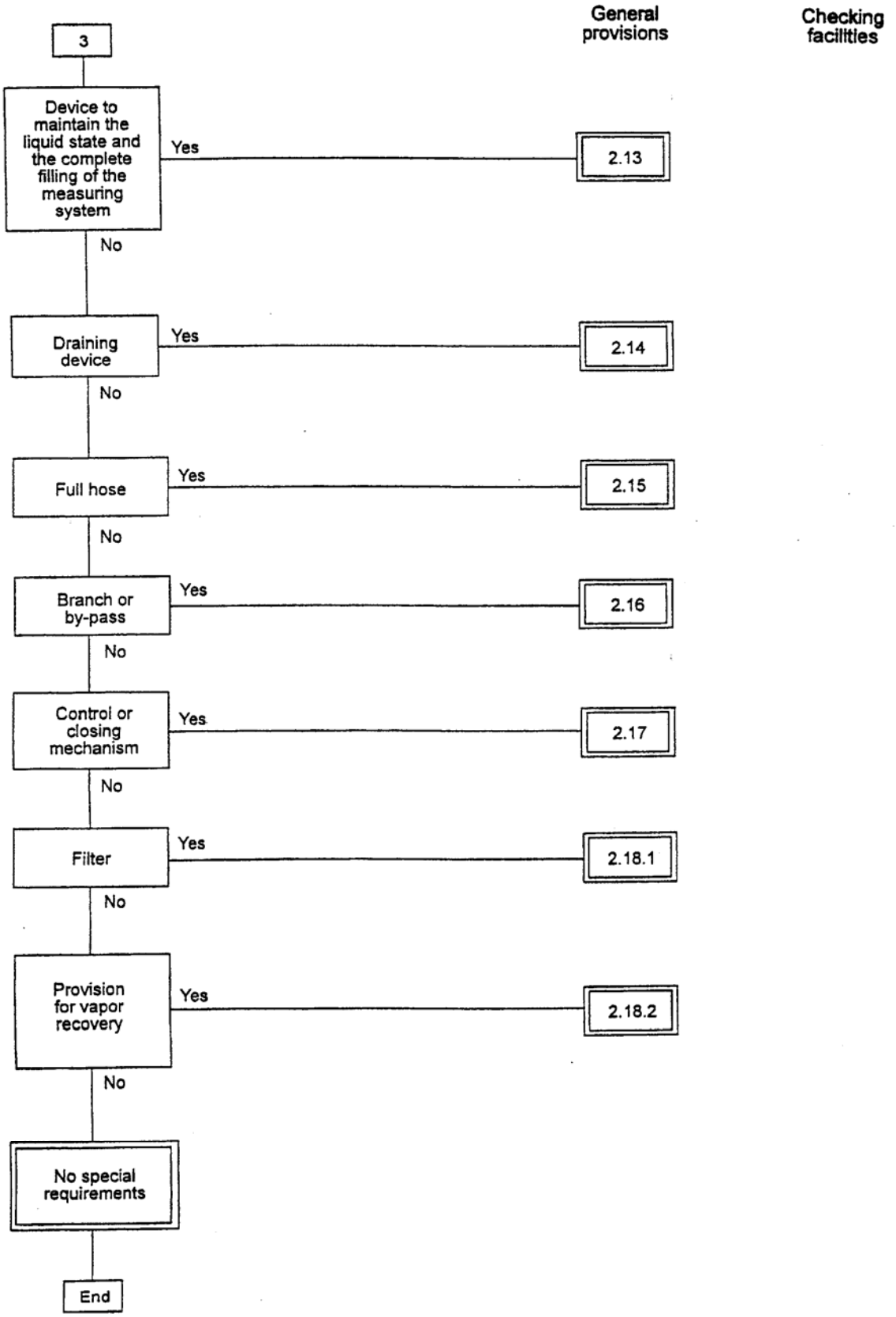

B
C
Measuring system for the unloading of ships' tanks and of rail and road tankers
Yes
5.3
No
Measuring system on pipeline or system for loading ships
Yes
5.6
No
General requirements
End

Devices of the measuring system




General provisions
Checking facilities
1
Calculator
Yes
General requirements
3.8
4.1
No
Special requirements
4.3.1
4.3.3
Volume or mass indicating device
Yes
General requirements
2.9
3.2.1
No
Mechanical indicating device
Yes
3.2.2
No
Electronic indicating device
Yes
3.2.3
4.3.1
4.3.4
Price indicating device
Yes
3.3
4.3.4
No
Printing device
Yes
3.4
No
Memory device
Yes
3.5
4.3.5
No
Pre-setting device
Yes
3.6
No
2


General provisions
Checking facilities
2
Conversion device
Yes
General requirements
3.7
No
Special requirements
2.7
Calculator
Yes
3.8
4.3.3
No
Associated measuring instrument
Yes
4.3.6
Power supply device
Yes
4.2
No
Gas elimination device
Yes
General requirements
2.10.1 to 2.10.7
No
Gas separator
Yes
2.10.8
No
Gas extractor
Yes
2.10.9
Gas indicator
Yes
2.11
No
Transfer point
Yes
2.12
No
3


General provisions
Checking facilities
3
Device to maintain the liquid state and the complete filling of the measuring system
Yes
2.13
No
Draining device
Yes
2.14
No
Full hose
Yes
2.15
No
Branch or by-pass
Yes
2.16
No
Control or closing mechanism
Yes
2.17
No
Filter
Yes
2.18.1
No
Provision for vapor recovery
Yes
2.18.2
No
No special requirements
End

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Below are references to publications of the International Electrotechnical Commission (IEC), the International Organisation for Standardisation (ISO) and the International Organisation for Legal Metrology (OIML). Where available, reference is also made to the corresponding Australian standards.

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