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Module F procedure for MI-005 Guideline for performing a Module F according to MID Annex VII (MI-005)

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WELMEC e.V. is a cooperation between the legal metrology authorities of the Member States of the European Union and EFTA. This document is one of a number of Guides published by WELMEC e.V. to provide guidance to manufacturers of measuring instruments and to notified bodies responsible for conformity assessment of their products. The Guides are purely advisory and do not themselves impose any restrictions or additional technical requirements beyond those contained in relevant EU Directives. Alternative approaches may be acceptable, but the guidance provided in this document represents the considered view of WELMEC e.V as to the best practice to be followed.

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1. Introduction

Under MID a measuring system for the continuous and dynamic measurement of quantities of liquids other than water (MS) can be placed on the market under module F (initial verification) by the manufacturer together with a NOBO only after a successful type examination (module B).

For performing module F, the manufacturer can choose a different NOBO than the NOBO who has issued the Type Examination Certificate (module B). Also, for each single module F assessment the manufacturer can choose a different NOBO.

As every module F can differ due to the involved parties (different manufacturers and NOBOs), a harmonized procedure for a module F is written so that all involved parties are aware on how to perform a module F and expectation of each party is clear.

Module F is the last step of the “B + F” option defined in Annex VII of the MID together with the essential requirements with the MID Directive to ensure compliance before it is put on the market.

The NOBO is not responsible for the EU declaration of conformity issued by the manufacturer. In case of deviations between the measuring system in process of conformity assessment and applicable EU-TEC the manufacturer shall contact the NOBO which issued the EU-TEC. Module F cannot start until open issues are clarified.

It shall be noted that the selection of a NOBO for the mandatory conformity assessment procedure for measuring systems according to module F is the responsibility of the manufacturer.

In the event that there are no recognized standards for the conformity test, the NOBO has the task of carrying out the conformity tests of the measuring system described in the EU-TEC, taking into account the manufacturer's recommendations.

This guide is provided as a “list of important items to focus attention on” in the execution of module F.

2. Scope

Purpose of this guide is to provide guidance and advice to NOBOs for performing a conformity assessment Module F on measuring instruments for continuous and dynamic measurement of quantities of liquids other than water instruments according to MID Annex VII (MI-005).

Before starting with the conformity assessment Module F, the manufacturer shall build the MS according to the applicable EU-TEC.

This guide does not cover conformity assessment Module F of fuel dispensers and LPG dispensers. Information on how to perform this can be found in R117-2 Annex A-I and A-LPG-I.

This guide is not intended to be mandatory.

3. Definitions, abbreviations and symbols

The definitions of OIML R117-1 edition 2019 apply to this guide.

Abbreviations:

EU-TEC	EU-Type examination certificate
EC	Evaluation Certificate

PC Parts Certificate
EUT Equipment under test
MID Measuring Instruments Directive (2014/32/EU)
MMQ Minimum measured quantity
MS Measuring System for the continuous and dynamic measurement of quantities of liquids other than water
NOBO Notified Body
MCUF Most commonly used flowrate during business with MS
Q_{MIN} The minimum flow rate as stated in the TEC of the MS
Q_{MAX} The maximum flow rate as stated in the TEC of the MS

4. Procedure Module F

For the Module F performed on a MS, the following steps need to be taken into account to complete the metrological examination and initial verification on site with the MS:

Generally, the NOBO preforming the module F should not redo the module B.

1. Examination for conformity of the MS according to the EU-TEC and (if applicable) the belonging Evaluation and/or Parts Certificates.
2. Check that the MS's parts (such as temperature and/or pressure sensors) metrological data are within the values specified in the EU-TEC and that the general requirements of the MID are met. If applicable, conversion and correction calculations shall also be checked. This includes that the settings are correct and that the read out is OK. If possible, with information from the user of the MS, that the correct conversion tables are used.
3. The metrological relevant components used to build a measuring system are stated in the EU-TEC. However, sometimes the metrological data according to the nameplate of these components actually installed in the MS can deviate from the EU-TEC for several reasons (e.g. wider approval ranges than the actual application ranges). Therefore it must be checked whether all metrological data are within the values specified in the EU-TEC and whether the general requirements of the MID are still met. The metrological values of all components used for the measuring system must be within the values specified on the nameplate of the measuring system.
4. In the case, the measurement is non-repeatable and one of the trading parties is absent, confirming a presence of a printing device and/or memory device. Device shall be used for the registration of the measurement data.
5. Verification of the correct parameter settings of the essential parts.
6. Checking the zero-offset (at zero flow) of the flow meter (if applicable).
7. Verifying the measurement accuracy of the measuring system. This can be done:
    a. Directly on site of installation by comparing the measurement results of a MS with results obtained by a calibrated master (e.g., master meter; weighing bridge, prover, standard capacity measure).
    b. Or
        i. By measurement in a test laboratory using a liquid with similar properties (density and viscosity) as the liquid to be measured with the MS.
        ii. The result of this investigation (7.b.i) is a calibration report, which states the results and the correct settings of all parameters, which are directly involved in the measurement (as a result of this investigation, they may have to be changed in respect of the original factory settings).
    c. Or
    Following the calibration instructions ('Conditions for conformity assessment') as mentioned in the applicable Evaluation/Parts Certificate of the measurement sensor and/or the applicable EU-TEC.
8. Make sure the MS is sealed.
9. When the Module F is completed successfully, the Module F certificate of conformity shall be issued by the NOBO

Remarks:
Chapter
gives more details regarding performance of testing and metrological examinations of the MS.

5. Performance tests and metrological examination

For the module F assessment, several tests and metrological examinations need to be performed on the MS. OIML R117-2 (2019) describes, for different types of MS, tests relevant for initial verification. Be aware that some measuring systems might require very specific tests (for example prime volume of milk measuring system, systems with hose reels etc.).

The suitable test procedures given in R117-2 should be followed. The paragraphs below are to be considered as additional guidance.

The TEC of the MS may also prescribe tests.

5.1 Test setup requirements

Before any tests can take place, the following test setup requirements shall be checked, including applied references used during calibrations/verifications:

5.1.1 Traceability to (inter)national standards

The applied reference / test equipment must have a traceable calibration to (inter-)national standards. For this reason, calibration certificates and their validity must be checked prior to conducting tests using the equipment concerned.

Results from calibrations by third parties that are done prior to the module F assessment are only acceptable if these results are traceable to international standards. This applies for the calibration of associated measuring instruments (thermometers, temperature- and pressure transmitters, density sensors etc.) and for the measuring sensor (flow meter).

In addition, with the calibration certificates and/or an uncertainty analysis, it must be shown that the applied reference / test equipment is suitable for the tests to be conducted. Using equipment having too high an uncertainty is not permitted since it compromises the confidence of decisions based on those test results.

Using non-traceable equipment is not acceptable.

5.1.2 Uncertainty of measurements

Following OIML R117 requirements when a test is conducted, the expanded uncertainty (U) of the determination of volume or mass indication error shall be less than 1/3 of the maximum permissible error applicable for that test during such as Module F.

However, if it is technically or economically impractical to reach an uncertainty (U) of 1/3 of the MPE, a “reduced MPE” is used. The reduced MPE is calculated according to the following formulas originating in OIML R 117-2, p. 4.2.2:

Reduced MPE = (4/3 × MPE – U)

The expanded uncertainty (U) is calculated according to the “Guide to the expression of uncertainty in measurement” (OIML version: G 1-100-en, 2008 edition) with 95% coverage (this is k = 2 in a normal distribution). In the calculation of the uncertainty, all major uncertainty contributions should be taken into account.

When calculating the expanded uncertainty, the resolution but not the repeatability of the EUT shall be included. This exception is only valid in the case of mutual agreement of the manufacturer and the test authority. Use of this exception shall be fully documented.

More information on uncertainty can be found in an annex (informative) to this guide.

5.2 Accuracy flow tests

Accuracy tests shall be performed either on the flow meter or on the complete MS.

Herewith at least three flow rates shall be covered during the accuracy testing. If the system or flow meter has been tested at site (or been tested at a laboratory) prior to the module F the NOBO can choose to take these tests into account, and choose to test on fewer flowrates, and/or fewer repetitions.
Laboratory testing would be an alternative way to test more than one flowrate for systems that cannot be tested at multiple flowrates at site.

Laboratory testing is ***critical*** for some meters like turbines or ultrasonic meters because the calibration depends on the flow profile. In some cases, the calibration will be done together with a flow conditioner that belongs to the meter. The correct position of the FC to the meter is marked and must be checked on site. Also the test liquid must fit to the liquid of later use.

If no prior testing has been performed, the following flowrates are suggested, if nothing else is stated in the TEC:

Q_{min} … Q_{min} +10%
40 % Q_{max} … 60 % Q_{max} *
80 % Q_{max} … Q_{max}.

* For some meters (for example turbine meters) the middle flowrate might vary from this due to the shape of the error curve of the meter. When testing these types of meters, one should test at the flow rates that derivate the most from the error curve. This is especially important if the MS do not have a flow computer with multiple point error curve correction.

To determine Q_{max} value see Chapter 5.7.

At each flow rate three repeated measurements shall be conducted. If it is not possible to do as many repeated measurements, one should try to do as many repeated measurements as possible.

In the applicable EU-TEC (EC, PC) of the flow meter or complete MS more guidance could be found on what liquid and at which flow rates the flow meter or complete MS shall be calibrated.

5.3 Zero flow verification tests

This test only applies for electro-magnetic, ultrasonic, and Coriolis meters.
The actual test is described in OIML R117-2 § 5.3.1
If other methods are available to verify the zero flow of the instrument, these methods can be used under the condition that the method is mentioned in the applicable EU-TEC, EC or PC.

5.4 MMQ tests

The actual test is described in OIML R117-2 §5.5

For a module F only the MMQ accuracy at the highest achievable flowrate shall be performed, if nothing else is stated in the EU-TEC, EC or PC.

Note: Achievable means with no spillage.

5.5 Prevention of gas/air tests

Test for prevention of gas/air are seldom performed for a module F.

The exceptions of:

- MS that under normal operating conditions empties storages tanks for example systems for road tankers and milk reception systems. See R117-2 for specifics on how to perform the tests.
- MS that has gas/air detectors that need different settings for each MS, due to electronical sensitivity or mechanical air/gas relieve adjustment possibilities. In these cases, this should be described in the EU-TEC. If not, actual test is described in OIML R117-2 §7.

5.6 Volume conversion tests

Testing of the actual conversion device is performed during the module B testing. During a module F one should check the settings of the conversion device.

Also, check that the tables and/or expansion coefficient used are suitable for the liquids measured. Be aware that these might vary from country to country depending on the “mixture” of for example biofuels.

Check that the converted results are within MPEs, this can be done parallel to the accuracy testing.

5.7 Maximum flowrate

Check that the maximum flowrate (Q_{max}) at site is within the described in the EC-TEC. For some MS this might have to be set at site due to for example capacity of pumps.

A Q_{max} corresponding to the actual Q_{max} achieved at site shall be stated on the nameplate. The Q_{max} achieved at site can be considered 80% of MS’ Q_{max}.

5.8 Targeted adjustment

At Article 2.8 of the MID the following is mentioned: “The measuring system shall not exploit the MPEs or systematically favour any party.”

This implies for all practical purposes that during testing the NOBO and manufacturer must make sure that the measurement error is as close to zero as possible. This can be very time consuming if one has to adjust the error curve for the entire flow rate range of a MS. It might also, not be

possible for all types of MS if the correction device does not have the capability to partially adjust the error curve.

Usually, a MS is used at a much narrower flowrate range in normal working mode. To comply with Article 2.8, one has to make sure that the MS in this range does not exploit the MPEs or favour any party.

Since one must take into account the measurement uncertainty during testing, please note the following. It is expected that any calibration result can carry a “noise” error of up to ± ⅓ of MPE (see § 5.1.2 for more explanation on the numbers chosen). When executing the test below, if a pullback to zero is required, the retest shall land within ± ⅓ of MPE (if not, something is wrong in the uncertainty calculation, or instrument/process is noisier than expected).

Clause 2.8 can be respected by doing following steps.

1. Determine and record the MCUF.
2. Do an accuracy test at MCUF.
3. If the error is found to be within ± ⅓ of MPE, the MS shall be deemed acceptable. If not, MS shall be pulled back to the closest to zero and test 2) redone.
4. Then, MS shall be tested at highest achievable flowrate and result shall be within ± MPE (if it is, test is conclusive). If the measurement uncertainty complies with shared risk, the MS shall be deemed acceptable.
   If not:
   a. If MS is outside of ± 4/3 of MPE, instrument is rejected
   b. If MS is inside (including) of ± 4/3 of MPE, redo test 4) once and only accept if this second test is within ± MPE
5. Then, MS shall be tested at low flowrate (as per type plate) and result shall be within ± MPE (if it is, test is conclusive). If the measurement uncertainty complies with shared risk, the MS shall be deemed acceptable.
   If not:
   a. If MS is outside of ± 4/3 of MPE, instrument is rejected
   b. If in MS is inside (including) of ± 4/3 of MPE, redo test 5) once and only accept if this second test is within ± MPE

5.9 Other specific tests to MS

For some measuring systems additional test might have to be performed. This should be described in the EU-TEC (or EC/PC).

If not and/or one comes across a “new” or “rare” MS to the NOBO special care to read through the corresponding paragraphs of R117-2 before starting the module F.

Annex A (informative)
Format Module F certificate

The following format can be used by the NOBO after the Module F is successfully performed:

Issued by	[NOBO name], designated and notified by [country name] to perform tasks with respect to conformity assessment procedures mentioned in article 17 of Directive 2014/32/EU, after having established that the Measuring instrument meets the applicable requirements of Directive 2014/32/EU, to:		
Manufacturer	[Name manufacturer] [Address] [Zip Code + City] [Country]		
Measuring instrument	An [interruptible or non-interruptible] measuring system for liquids other than water		
	Type designation Serial number	: :	[type designation measuring system] [serial number measuring system]
	Gas elimination device Serial number	: :	[producer name with type designation] [serial number component]
	Measurement sensor Serial number	: :	[producer name with type designation] [serial number component]
	Measurement transducer Serial number	: :	[producer name with type designation] [serial number component]
	Calculating/indicating device Serial number	: :	[producer name with type designation] [serial number component]
	Temperature sensor Serial number	: :	[producer name with type designation] [serial number component]
	Pressure sensor Serial number	: :	[producer name with type designation] [serial number component]
Applicable approval	EU-type examination certificate, number [certificate number]		
Examinations	According to normative document OIML R117-1		
Location	[Location measuring system]		
Verification date	[date]		
Conformity procedure	Annex II, Module F of Directive 2014/32/EU		
Issuing Authority	[NOBO name], Notified Body number [no.] [signature date] [signature]		

Annex B (informative)
Checklist Module F

The following checklist format can be used by the manufacturer and NOBO for the Module F:

General information

Order reference		Date	
Verification officer			
Contact person customer		Phone number(s)	
Address			

Reference documents and resources needed on site

☐	EU-type examination Certificate: revision:			☐ Latest revision
☐	Documentation folder:			☐ Latest revision
☐	Flow meter		☐ Factory calibration data is available (incl. calibration parameters)	
	Sensor type:	☐	Evaluation / Parts Certificate: revision:	☐ Latest revision
		☐	Documentation folder:	☐ Latest revision
	Transducer type:	☐	Evaluation / Parts Certificate: revision:	☐ Latest revision
		☐	Documentation folder:	☐ Latest revision
☐	Gas elimination device			
	Type:	☐	Evaluation / Parts Certificate: revision:	☐ Latest revision
		☐	Documentation folder:	☐ Latest revision
☐	Electronic calculating/indicating device (electronic counter or flow computer)			
	Type:	☐	Evaluation / Parts Certificate: revision:	☐ Latest revision
		☐	Documentation folder:	☐ Latest revision
☐	Self-service device			
	Type:	☐	Evaluation / Parts Certificate: revision:	☐ Latest revision
		☐	Documentation folder:	☐ Latest revision
☐	Temperature transducer			
	Type:	☐	Evaluation / Parts Certificate: revision:	☐ Latest revision
		☐	Documentation folder:	☐ Latest revision
☐	Pressure transducer			
	Type:	☐	Evaluation / Parts Certificate:	☐ Latest revision

			revision:	
		☐	Documentation folder:	☐ Latest revision
☐	Density transducer			
	Type:	☐	Evaluation / Parts Certificate: revision:	☐ Latest revision
		☐	Documentation folder:	☐ Latest revision
☐	Personal Safety Measures (Steel tip shoes, overall, hard hat, safety glasses and gloves)			
☐	Calibration data of the used reference instruments.			
☐	Sealing tools			

Checklist performing the conformity assessment

☐	Inscriptions on the nameplate are correct and according to EU-TEC
☐	Inscription of the MMQ on the indicator face of the calculating/indicating device.
☐	Inscriptions of the essential parts are as mentioned in the applicable Evaluation or Parts Certificate are correct and accordingly.
☐	Note the serial numbers, software version(s) and checksum(s) of the essential parts in the list “Unique information of the MS” in paragraph Unique information of the MS.
☐	Reference instruments traceable to (inter)national standards and the calibration period is not exceeded.
☐	Verify the (parameter) settings of the parts of the MS, especially: Flow meter specific: Compare the settings with the mandatory settings given in applicable EC / PC Calibration parameters (if applicable) Low flow cut off (≤ 20 % of Q_{min} of the complete MS) Electronic counter Compare the settings with the mandatory settings given in applicable EC / PC Self-service device Compare the settings with the mandatory settings given in applicable EC / PC
☐	Temperature conversion: Compare the settings with the mandatory settings given in applicable EC / PC
☐	Alarms: Check if alarms generated by the flow meter are communicated to the electronic counter and are stored or printed.
☐	Print out / storage of measurement data: Compare if the indicated measurement is identical with the printout or storage (memory device) of the measurement device and is also identical on the self-service device.
☐	Performance tests and metrological examination: On the MS performance tests needs to be executed, taken into account the following tests: Accuracy flow tests Zero flow verification tests MMQ tests Prevention of gas/air tests Functional tests Details can be found in chapter **Performance tes**.
☐	Apply seals as prescribed in the EU-TEC and the applicable EC / PC
☐	Optionally and if allowed, take picture of: Complete MS Essential parts (including inscriptions and sealing) Nameplate

Unique information of the MS

Serial number		
Minimum flow rate (Q_{min})		
Maximum flow rate (Q_{max})		
Ratio Q_{min} : Q_{max}		☐ At least 1:5
Minimum Measured Quantity		
Location		

Part	**Serial number**	**Software version / Checksum**
Measurement sensor		
Measurement transducer		
Gas elimination device		
Electronic counter		
Flow computer		
Self-service device		
Temperature transducer		
Pressure transducer		
Density transducer		

Test results

Test no.	**Flow rate**	**Indication** (I) [L / m^3 / kg]	**Reference** (R) [L / m^3 / kg]	**Difference** (D=I-R) [L / m^3 / kg]	**Error** (E=D/R*100) [%]	**Remarks**

Notes

Annex C
Uncertainty (informative)

This annex gives a list of possible uncertainty contributions when using different reference equipment for flow measurement. The list of contributions is not exhaustive. The operator preforming the measurement must always consider his (or her) own methods, equipment and other influence parameters at site.

On a general note:
The number of repeated measurements is determined by the required uncertainty of measurement. A good practise is to calculate an expanded measurement uncertainty U_{TOT} [%] excluding the uncertainty resulting from the repeatability U_R of the EUT. The repeatability then follows from

$$\frac{1}{3} \cdot MPE = \sqrt{U_{TOT}^2 + U_R^2}$$

Repeatability is also mentioned in R117-1 clause 3.1.2.2. This gives a value for the maximum error from repeatability.

1. Volume standards

Measurement uncertainty contributions when preforming measurements using *volume standards* may account to

- calibration process of a volume standard
- drift of a volume standard
- indication error of a volume standard
- resolution (of a reading) of a volume standard
- resolution (of a reading) of EUT
- temperature compression factor of a fluid
- temperature difference between media temperature as measured in an instrument and in volume standard
- temperature difference between temperature of a volume standard's material and media in a volume standard
- Fluid evaporation (see explanation below)
- Fluid misting (se explanation below)
- Wetting process
- etc

2. Fluid evaporation

When a calibration can is first filled with fuel (during wetting process), the idea is to create a "film" of liquid that is repeatable so prover is repeatable (and not needing to be dried out at each check). That is part of the calibration process of provers with labs (see R120).

After such “wetting”, when can is emptied, fresh air enters the prover and evaporates part of the “film” left by the liquid. Such is normal and very significant for fuels such as UL95 and UL98.
That creates an error making the can “bigger” than expected.

During the subsequent fill (with such unleaded fuels), the nozzle spraying creates an accelerated evaporation, that tends to evaporate part of the measured liquid to complete and saturate the vapour pressure (function of T) inside the prover. Such vapours come from measured liquid and disappear as they are expelled by the liquid rising in the can.

There are solutions in existing patents, to secure vapours inside the prover during the emptying process (or to reduce the ingress/presence of fresh air)

Depending on conditions, operator, can size and shape, arrangement, fuel and way the can empties, this error is rather systematic but has a quite wide sigma.

3. Fluid misting

When a calibration can is filled with fuel at 40 l/min (example, usual flowrate for dispensers), the incoming flow of fuel meets the outgoing flow of vapours (expelled from the can at 40 l/min). Such flow is capable of dragging out any mist created by the nozzle. In addition, trouble is that nozzle is indeed creating such mist because of the safety venturi system (automatic stop).
This is more sensitive with unleaded, but does exist with other liquids.

There are solutions in existing patents to avoid such.

Depending on conditions, operator, can size and shape, arrangement and fuel, this error is rather systematic but has a quite wide sigma.

4. Reference meters

Measurement uncertainty contributions when preforming measurements using for example *mass flow meter (Coriolis)* as a standard may account to:

- calibration process of a MFM standard
- drift of a MFM standard and estimation of an indication error due to readings between the calibration points
- resolution (of a reading) of a MFM standard
- systematic error due to a calibration of a MFM standard using water and not a media used in a measurement process
- resolution (of a reading) of an instrument
- temperature compression factor of a fluid
- etc

5. Other reference equipment

This can for example be compact/pipe provers or weighing instruments. The uncertainty contributions for this reference equipment follow the same pattern as for the above-mentioned instruments.

- Calibration of the standard
- Drift of the standard
- Resolution (of a reading) of the standard
- resolution (of a reading) of an instrument
- Temperature

- Etc

Be extra aware of influences from wind and rain when using weighing instruments outdoors.