

WELMEC Guide 10.12

Testing Meter Sensors

Guideline for Assessing and Testing MI-005 Meter Sensors

Version 2025



WELMEC 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 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 as to the best practice to be followed.

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1 Introduction

Meter sensor testing is highly dependent of manufacturer's technology and architecture of measuring systems. As such, manufacturers shall disclose and provide guidance to NOBO's to allow better and easier testing and evaluation of meter sensors alone.

2 Scope

Purpose of this guide is allow for a simplified assessment for manufacturers when a measuring sensor (e.g.: meter and pulser or transducer) is to be tested and evaluated for a wide range of instruments. Various documents shall be established by manufacturer and adequately documented with technical documentation and explanations.

3 Definitions, abbreviations and symbols

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

Abbreviations:

NOBO	Notified Body
ATC	Automatic Temperature Compensation
Misc	Miscellaneous

4 Technical description of meter sensor family

The manufacturer shall establish the list of all core characteristics of meter sensor / meter sensor family, to associate each constituent component (part) of a meter sensor with a technical compatibility scheme. Information is proprietary and confidential, and shall help NOBO's in assessing:

- a) Nature of influence of technical specifications with metrology requirements
- b) Compatibility arrangement between related parts of meter sensor
- c) Level of testing/re-testing required to gain confidence during evaluation process

A list of Technical specifications is to be provided by the manufacturer. The list shall comprise of at least the following items (this list shall not create any obstacles to the regulatory requirements within OIML R117-1):

- Nature of fluid, viscosity, temperature range of liquid
- Maximum and minimum working pressure
- Maximum and minimum flowrate
- Cyclic volume of meter (if applicable)
- Digital information for flow
- Digital communication between the sensor and the calculator
- Ambient temperature range for mechanical part (fluid contact)
- Ambient temperature range for electronic part (when applicable)
- Position of meter versus verticality

Some examples of the additional specifications that can be included (but only if considered relevant by the manufacturer)

- Level of contamination of fluid (particles, other contaminants, minimal and maximal pH, conductivity)
- Maximum flowrate acceleration/deceleration
- Diameter of fluid path when relevant

Note: Risk assessments established with this guidance can be used to establish mandatory risk assessment in Directive 2014/32/EU.

5 Evaluation of adjacent compatibility requirements

Adjacent compatibility requirements are specifics linked to how meter sensor shall be implemented/used.

A list of adjacent compatibility requirements is to be provided by manufacturer. The list shall comprise of at least the following items (this list shall not create any obstacle to the regulatory requirements within OIML R117-1):

- Upstream Anti-swirl or flow straightener requirements, and minimal specification
- Non-return valve requirements, upstream and/or downstream (and pressure discharge specification). If non-return valve function is replaced by a software or electronic arrangement built inside meter sensor, it shall be specified here.
- If meter sensor includes an ATC function, the manufacturer shall ensure that the required parameters are made known and able to be disengaged for verification/testing purposes

5.1 Example of evaluation declaration list

The following list is an example given for a piston meter associated to a separate (different manufacturer/origin) pulser.

Nature of fluid, viscosity, temperature range of liquid	Petrol, gasoline, diesel, ethanol blends, bio-diesel blends, kerosene, heating fuel Viscosity: 0,4 mPa·s - 17 mPa·s
Minimum and maximum working pressure	From 1,5 to 3,5 bar
Minimum and maximum flowrate	From 0 to 80 L/min
Cyclic volume of measuring sensor	0.5 litre per revolution of shaft
Digital information for flow	1 pulse per 0,01 litre (50 pulses per revolution). Transmission ratio: 1 to 1
Digital communication of sensor with calculator	3 channels, TTL levels, 60° phase shift with overlap
Ambient temperature range for mechanical part	-40 °C to +55 °C
Ambient temperature range for electronic part	-40 °C to +55 °C
Position of meter versus verticality	Horizontal or Vertical
Anti-swirl	Not applicable
Non return valve	Upstream meter
Reverse counting arrangement	Play of 90° (0,12 L) in mechanical coupling between meter shaft and pulser.
Diameter	DN 25

6 Risk assessment table

This is only a set of suggestions. The manufacturer shall assess the need and adequateness for each situation and the real compatibility constraints and risks.

Evaluation	Upstream	Measuring hydraulic cell	Electronic transducer	Misc (ATC or e-calib)	Downstream	Calculator
Upstream	X	MFC1	MFC2	MFC3	MFC4	MFC5
Measuring hydraulic Cell	EESC1	X	MFC6	MFC7	MFC8	MFC9
Electronic transducer	EESC2	EESC5	X	MFC10	MFC11	MFC12
Misc (ATC or e-calib)	EESC3	EESC6	EESC8	X	MFC13	MFC14
Downstream	EESC4	EESC7	EESC9	EESC10	X	MFC15
Calculator	EESC12	EESC13	EESC14	EESC14	EESC15	X

The focus should be on the:

- a) nature of the relationship (Mechanical+Fluid at top of table, Electrical/Electric/Software at bottom)
- b) compatibility arrangement between related parts for each applicable nature of the relationship
- c) level of risk for each relationship

MFC: Mechanical/Fluid Compatibility

MFC1 to MFC15: describe specifics about mechanical and fluid compatibility when using related components in combination for the considered measuring instrument.

When relevant, this should **comprise an assessment (risk assessment if needed)** for

- Mechanical mounting considerations, interfacing mechanically, alignment or stress
- Mechanical transmission of information and protection against physical disturbances
- Piping and fluid connection considerations
- Need for specifics pipe length or flow straightening

EESC: Electronic/Electric/Software Compatibility

EESC1 to EESC15: describe the specifics relating to the electronics, electrics and software compatibility when using related components in combination for the considered measuring instrument

When relevant, this should **comprise an assessment (risk assessment if needed)** for

- EMC protection when links are potential risks of acting as EMC disturbance antennas (or length limitations and grounding constraints)
- Electrical/electronic real time data transfer constraints (non-purely digital information) with maximum acceptable frequencies for events
- Communication protocol constraints (minimum revision if applicable) and definition of communication protocol standard (either public or proprietary)
- Wire identification requirements (connection information) and connector(s) to use

6.1 Example for the piston meter and pulser of paragraph 5.1

This is only a set of suggestion. The manufacturer shall assess the need and adequateness for each situation and the real compatibility constraints and risks.

<u>EVAL</u>	Upstream including incoming compatible flow modes	Measuring hydraulic cell	Electronic transducer	Misc (ATC or e-calib)	Downstream Including transfer point	Calculator
Non-return valve	X	MFC1	MFC2			
Mechanical piston meter		X	MFC3			
Pulser			X			
No misc				X		
No downstream					X	
Calculator			EESC1			X

The focus should be on the:

- a) nature of the relationship (Mechanical+Fluid at top of table, Electrical/Electric/Software at bottom)
- b) compatibility arrangement between related parts for each applicable nature of the relationship
- c) level of risk for each relationship

MFC: Mechanical/Fluid Compatibility

MFC1: The volume of liquid between the non-return valve and the meter inlet shall not exceed 1 litre, and shall not trap air bubbles

MFC2: The non-return valve may be fitted with an over-pressure discharge valve. The pulser/meter arrangement shall ensure that reverse flow does not influence the measurement. See MFC3 and EESC1

MFC3: The meter shaft is coupled directly to the pulser with no intermediate gear(ing). The coupling between the shafts of the meter and the pulser shall allow for mechanical misalignment and for reverse flow* of the meter for at least 0.1 litre. Check EESC1 for error detection in case reverse flow exceeds 0.1 litre.

*) OIML R117-1:2019 5.7.3 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.

EESC: Electronic/Electric/Software Compatibility

EESC1:

- Pulser delivers 3 channels with overlap, so 000 and 111 are error configurations (detect pulser disconnected)

- Reverse counting (in excess of the play in the meter-pulser coupling) shall be detected by wrong phase shift between channels
- Pulser power (5V DC, 100 mA) provided by calculator. Start-up time: 1 ms at power up. TTL levels. Impedance for each channel: 330 Ω
- One pulse on each channel per centilitre. Calculator shall be capable of processing events at 800 hz for each meter connected (increase by safety margin).
- Grounding of the cable shielding e inside the pulser housing. Pulser housing shall be grounded mechanically to the frame of the instrument.

7 Testing

Testing process shall be suggested by the manufacturer to cover:

- All regulatory requirements when relevant (OIML R117-1)
- Using all technical information of chapter 4
- Using all relevant adjacent arrangement specifications of chapter 5
- To confirm compliance with specifications listed in evaluation declaration list of chapter 5.1
- Adequateness of testing, which shall be confirmed with risk assessment table of chapter 6

For the tests the manufacturer is required to provide a “calculator” capable of reading information from meter sensor as per proprietary specification of manufacturer. The calculator is not included as part of the EUT and shall not be submitted to the following tests of influence factors.

Testing shall cover:

- Accuracy over flowrate range, and depending of measuring technology, several intermediate flowrates
- Accuracy over flowrate limits (high flow and low flow) at ambient and fluid temperature limits (high and low, combined)
- After endurance run, check drift from initial calibration curve over the flowrate range limits (high flow and low flow) and normal ambient (air 15°C +/- 10°C, fluid 15°C +/- 5°C)
- After endurance run, check drift from initial calibration curve over the flowrate limits (high flow and low flow) at ambient and fluid temperature limits (high and low, combined)
- Reverse overflow detection test
- Pulser disconnection and reconnection before and during transaction – VCC, GND, Channels or data communication – observations to be recorded and assessed versus the manufacturer’s declared specification – note 1

Note 1: In the case of smart pulsers, some disconnections might be detected and/or compensated for.

Revision History

Version	Significant changes
2019	First version
2025	Update to OIML R117:2019