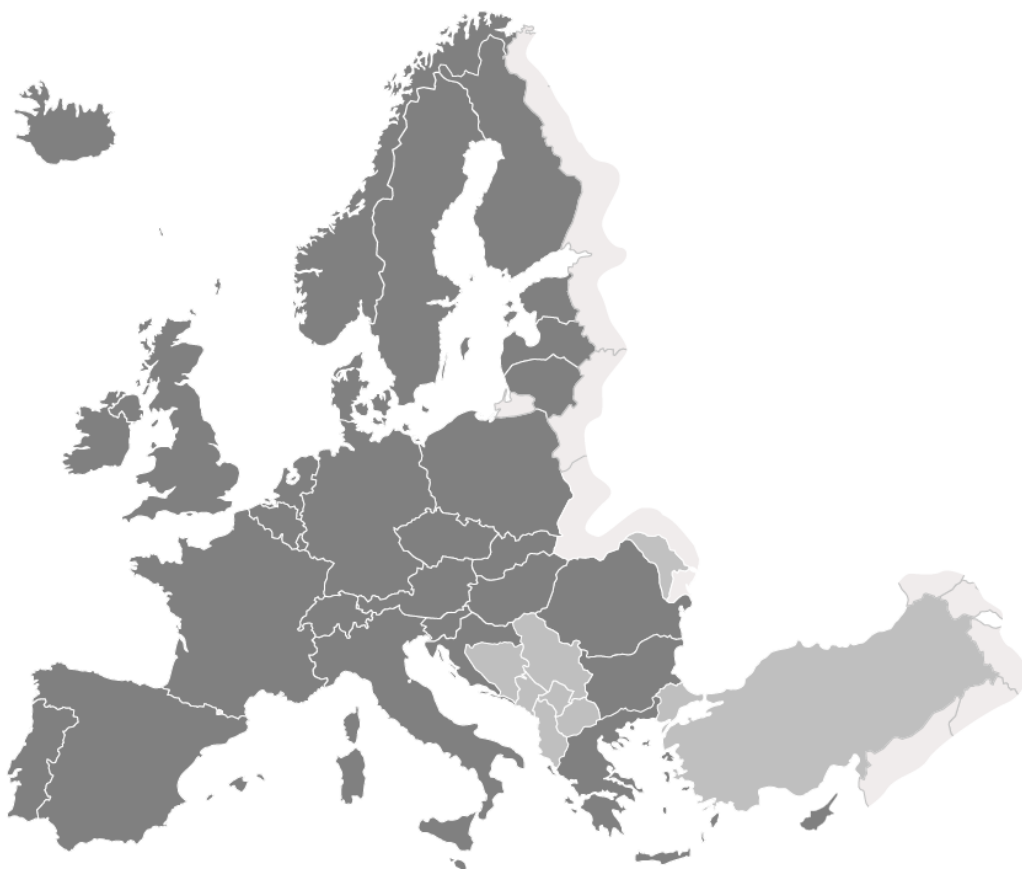# WELMEC

European Cooperation in Legal Metrology

Compatibility Sheet
Guideline for Manufacturers to establish
Compatibility Sheets for MI-005 measuring instruments

WELMEC

European Cooperation in Legal Metrology

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.

Contents

1 Introduction

A compatibility sheet is a tool to help NOBOs to quickly assess situations regarding measuring instruments of "liquids other than water" by reducing the number of tests and checks between constituent elements of a measuring instrument. In some way, the compatibility sheet is a "risk assessment" from the manufacturer to reduce the amount of work for module B, D or F authorities. It also contributes to MID NLF requirement for risk assessment.

2 Scope

The purpose of this tool is also to simplify the assessment for manufacturers when only one component is changed (alternative) in a given instrument structure (module B variation).
The compatibility sheet has to be established by manufacturer and adequately documented with technical documentation and explanations.

The purpose of the compatibility sheet is only to describe the compatibility relationship constraints between components when needed (and not to describe the compatibility of component alone (itself) versus the intent use of the fully built instrument).

3 Definitions, abbreviations and symbols

The definitions of OIML R117-1 edition 2007 apply to this guide.

Abbreviations:

MID	Measuring Instruments Directive
NLF	New Legislative Framework
NOBO	Notified Body
IMS	Industrial Measuring System
EC	Evaluation Certificate as defined in WELMEC guide 8.8
PC	Parts Certificate as defined in WELMEC guide 8.8
TC	Test Certificate as defined in WELMEC guide 8.8

4 Module B

The specific Module B sheet shall clearly indicate the one-to-one relationship of the components in the instrument.

The manufacturer shall:
- establish a list of all constituent components (sub-assemblies, parts);
- define the relationship between each of them (using a two dimensions array); and
- provide comments for each identified relationship:

The comments shall include the:
a) nature of the relationship (Mechanical+Fluid at top, Electrical/Software at bottom)
b) compatibility arrangement(s) between related components (sub-assemblies, parts) for each applicable nature of the relationship
c) level of risk for each component (sub-assembly, part), **and EC/PC/TC references to manage the risk upstream**

5 Module D and F

The specific Module D or F sheet shall clearly indicate the one-to-one relationship of the components in the instrument.

The manufacturer shall:
- establish a list of all constituent components (sub-assemblies, parts);
- define the relationship between each of them (using a two dimensions array); and
- provide comments for each identified relationship:

The comments shall include the:
a) nature of the relationship (Mechanical+Fluid at top, Electrical/Software at bottom)
b) compatibility arrangement **between the related components (sub-assemblies, parts) based on EC/PC/TC information if more than one is involved for any of the two components involved**
c) **nature of first verification test required (if any) to prevent risk. The purpose is NOT to redo testing conducted for module B, but to only establish a simple sanity check for module D or F**

Note:

- The reader shall assume that module G is combination in sequence of module B and module F.

6 Examples module B

6.1 General case

This is only a set of suggestion. The manufacturer shall assess the need and adequateness, for each situation and real compatibility constraints and risks. This requires state of the art understanding over instrument and how its constituents contribute to the measurement in the build.

Module B	Component 1	Component 2	Component 3	Component 4	Component 5
Component 1	X	MFC1	MFC2	MFC3	MFC4
Component 2	EESC1	X	MFC5	MFC6	MFC7
Component 3	EESC2	EESC5	X	MFC8	MFC9
Component 4	EESC3	EESC6	EESC8	X	MFC10
Component 5	EESC4	EESC7	EESC9	EESC10	X

The focus should be on the:
  a) nature of the relationship (Mechanical+Fluid at top, Electrical/Software at bottom)
  b) compatibility arrangement(s) between related components (sub-assemblies, parts) for each applicable nature of the relationship
  c) level of risk for each component (sub-assembly, part), **and EC/PC/TC references to manage the risk upstream**

MFC: Mechanical/Fluid Compatibility

MFC1 to MFC10: 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 EESC10: describe specifics about the compatibility of the electronics, electrics and software 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

6.2 Example for module B for Petrol Dispensers

Study case for this example: A petrol dispenser using old (20 years old) technology (static vortex air separator, reading pulses from the pulser, the pulser is driven by the meter and the calculator directly driving the display) for module B.

The following information is given as DELIVERABLE from MANUFACTURER to APPROVAL FOLDER and NOBO:

Module B	Air separator	Meter	Pulser	Calculator	Display	Transfer point
Air separator	X	MFC1	X	X	X	X
Meter	EESC1	X	MFC2	X	X	MFC5
Pulser	X	EESC2	X	MFC3	X	MFC5
Calculator	X	X	EESC3	X	MFC4	MFC5
Display	X	X	X	EESC4	X	X
Transfer point	X	EESC5	EESC5	EESC5	X	X

The focus should be on the:
   a) nature of the relationship (Mechanical+Fluid at top, Electrical/Software at bottom)
   b) compatibility arrangement(s) between related components (sub-assemblies, parts) for each applicable nature of the relationship
   c) level of risk for each component (sub-assembly, part), **and EC/PC/TC references to manage the risk upstream**

MFC: Mechanical/Fluid Compatibility

MFC1: air separator shall have adequate flowrate capability versus meter(s) downstream. Admin control of relevant EC/PC/TC for both components and request for module B type approval from manufacturer. Check also technical data from PC or technical folder for EC/TC

MFC2: meter and pulser coupling shall be safe, immune to mechanical external disturbance, immune to thermal effect, and compatible for expected effect (number of pulses per revolution). Check of technical data of the pulser and meter (cyclic volume, gear arrangement, pulser number of pulses per rev). Check also technical data from PC or technical folder for EC/TC

MFC3: no fluid or mechanical compatibility risk

MFC4: no fluid or mechanical compatibility risk

MFC5: mechanical (thermal) expansion of liquid in hose shall not leak from the nozzle. The nozzle shall keep hose full, and any unexpected overpressure inside idle hose shall be allowed to flow back via the meter and pressure release valve to avoid rupturing of the hose. As such, the impact on the next transaction (including hose inflation) shall be adequately accounted for in combination with EESC5

EESC: Electronic/Electric/Software Compatibility

EESC1: no EES compatibility risk

EESC2: no EES compatibility risk

EESC3: pulser and calculator shall have adequate compatibility for
   - Multi-channel information (electrical levels, duty cycle, phase shift between channels)
   - Power supply stability from calculator to pulser
   - Grounding and EMC testing between pulser and calculator
   - Shannon relation for maximum flowrate (and combined when multiple pulsers)
   - Thermal compatibility of both components possible shift over temperature range
   - Check PC or technical data associated to EC/TC for conformity of the pulser with calculator

EESC4: display and calculator shall have adequate compatibility for
- Each and every cable connecting both components
- Power supply stability from calculator to display
- Grounding and EMC testing between display and calculator
- Thermal compatibility of both components possible shift over temperature range
- Adequate sensing of drivers of calculator controlling display
- Check PC or technical data associated to EC/TC for conformity of display with calculator

EESC5: reverse flow from sun radiation on hose, or vehicle running over hose, shall be allowed as per MFC5. Adequate compensation in pulser assembly construction, and/or hose inflation masking at start of next transaction, shall secure accuracy of all transactions.

6.3 Example for module B for Industrial Measuring Systems

Study case: IMS on trucks, to deliver heating fuel to home. The system is using old (20 years old) technology (simple air-separator, reading pulses from pulser, the pulser driven by a vane meter, a calculator directly driving the display and a printer) for module B.

The following information is given as DELIVERABLE from MANUFACTURER to APPROVAL FOLDER and NOBO:

Module B	Vehicle power	Air separator	Meter	Pulser	Calculator	Display	Printer	Transfer point
Vehicle power	X	X	X	X	X	X	X	X
Air separator	X	X	MFC1	X	X	X	X	X
Meter	X	EESC1	X	MFC2	X	X	X	X
Pulser	X	X	EESC2	X	MFC3	X	X	X
Calculator	EESC6	X	X	EESC3	X	MFC4	X	MFC5
Display	X	X	X	X	EESC4	X	X	X
Printer	X	X	X	X	EESC5	X	X	X
Transfer point	X	X	X	X	EESC7	X	X	X

The focus should be on the:
   a) nature of the relationship (Mechanical+Fluid at top, Electrical/Software at bottom)
   b) compatibility arrangement(s) between related components (sub-assemblies, parts) for each applicable nature of the relationship
   c) level of risk for each component (sub-assembly, part), **and EC/PC/TC references to manage the risk upstream**

MFC: Mechanical/Fluid Compatibility

MFC1: air separator shall have adequate flowrate capability versus meter(s) downstream. Admin control of relevant EC/PC/TC for both components and request for module B type approval from manufacturer. Check also technical data from PC or technical folder for EC/TC. Other need for components in piping to be considered (anti-swirl device, absence of air intake points, presence of non-return valves)

MFC2: meter and pulser coupling shall be safe, immune to mechanical external disturbance, immune to thermal effect, and compatible for expected effect (number of pulses per revolution). Check of technical data of pulser and meter (cyclic volume, gear arrangement, pulser number of pulses per rev). Check also technical data from PC or technical folder for EC/TC. **In IMS, resistance to vibration shall be assessed.**

MFC3: no fluid or mechanical compatibility risk

MFC4: no fluid or mechanical compatibility risk

MFC5: liquid in hose shall not leak from nozzle, nozzle shall retain liquid in hose till emptying at end of transaction.

EESC: Electronic/Electric/Software Compatibility

EESC1: no EES compatibility risk

EESC2: no EES compatibility risk

EESC3: pulser and calculator shall have adequate compatibility for
   - Multi-channel information (electrical levels, duty cycle, phase shift between channels)
   - Power supply stability from calculator to pulser
   - Grounding and EMC testing between pulser and calculator

- Shannon relation for maximum flowrate (and combined when multiple pulsers)
- Thermal compatibility of both components possible shift over temperature range
- Check PC or technical data associated to EC/TC for conformity of pulser with calculator

EESC4: display and calculator shall have adequate compatibility for
- Each and every cable connecting both components
- Power supply stability from calculator to display
- Grounding and EMC testing between display and calculator
- Thermal compatibility of both components possible shift over temperature range
- Adequate sensing of drivers of calculator controlling display
- Check PC or technical data associated to EC/TC for conformity of display with calculator

EESC5: Printer and calculator shall have adequate compatibility for
- Each and every cable connecting both components
- Power supply stability from calculator to Printer *(unless Printer powered from vehicle: in such case, a specific EESCx case to be assessed for such relation)*
- Grounding and EMC testing between printer and calculator
- Thermal compatibility of both components possible shift over temperature range
- Adequate sensing of drivers of calculator controlling link to printer and fault reporting
- Check PC or technical data associated to EC/TC for conformity of printer with calculator

EESC6: Vehicle power and calculator shall have adequate compatibility for
- Each and every cable connecting calculator to main power
- Power supply stability when engine running and when engine is turned off
- Grounding and EMC testing of calculator on vehicle
- Right power fault detection
- Check reaction of instrument if engine started during transaction
- Check PC or technical data associated to EC/TC for requirements of calculator

EESC7: calculator shall remind (by adequate sticker or signal) that the hose shall be emptied to the customer side when transaction is stopped.

7 Example for module D and F

7.1 General case

This is only a set of suggestion. Manufacturer shall assess need for each, and adequateness to situation and real compatibility constraints and risks.

Module D or F	Component 1	Component 2	Component 3	Component 4	Component 5
Component 1	X	MFC1	MFC2	MFC3	MFC4
Component 2	EESC1	X	MFC5	MFC6	MFC7
Component 3	EESC2	EESC5	X	MFC8	MFC9
Component 4	EESC3	EESC6	EESC8	X	MFC10
Component 5	EESC4	EESC7	EESC9	EESC10	X

The focus should be on the:

a) nature of the relationship (Mechanical+Fluid at top, Electrical/Software at bottom)
b) compatibility arrangement(s) **between the related components (sub-assemblies, parts) based on EC/PC/TC information if more than one is involved for any of the two components involved**
c) **nature of first verification test required (if any) to prevent risk**

MFC: Mechanical/Fluid Compatibility

MFC1 to MFC10: describe specifics about mechanical and fluid compatibility when using related components in combination for the considered measuring instrument.
When relevant, this should **comprise guidance for the first verification** (and associated risk assessment if needed) for
- Mechanical mounting guidance, interfacing mechanically, alignment or stress (torque)
- Guidance on how to check immunity against physical disturbances
- Piping and fluid connection checks to be conducted and a list of items to be checked for their presence

EESC: Electronic/Electric/Software Compatibility

EESC1 to EESC10: describe specifics about the compatibility of the electronics, electrics and software when using related components in combination for the considered measuring instrument
This should **comprise guidance for the first verification** (and associated risk assessment if needed) for
- Adequate position for EMC protections on components and links
- Maximum length for each link, and description of compatible cables for a visual check

Admin check of protocol compatibility (where to find information) for both components

7.2 Example for module D and F for Petrol Dispensers

Study case for this example: Same petrol dispenser as described in paragraph 6.2 using old (20 years old) technology (static vortex air separator, reading pulses from the pulser, the pulser is driven by the meter and the calculator directly driving the display) for module D or F.

The following information is given as DELIVERABLE from MANUFACTURER to APPROVAL FOLDER and NOBO for module D approval or NOBO module F execution on site:

Module D or F	Air separator	Meter	Pulser	Calculator	Display	Transfer point
Air separator	X	MFC1	X	X	X	X
Meter	EESC1	X	MFC2	X	X	MFC5
Pulser	X	EESC2	X	MFC3	X	MFC5
Calculator	X	X	EESC4	X	MFC4	MFC5
Display	X	X	X	EESC4	X	X
Transfer point		EESC5	EESC5	EESC5	X	X

The focus should be on the:

a) nature of the relationship (Mechanical+Fluid at top, Electrical/Software at bottom)
b) compatibility arrangement(s) **between the related components (sub-assemblies, parts) based on EC/PC/TC information if more than one is involved for any of the two components involved**
c) **nature of first verification test required (if any) to prevent risk**

MFC: Mechanical/fluid compatibility

MFC1: check piping arrangement / diagram and check module B versus each component for EC/PC/TC reference. Check fluid in use for instrument compatibility (versus components): viscosity
MFC2: check that no mechanical interferences are possible to the shaft connection between meter and pulser
MFC3: no fluid or mechanical compatibility risk
MFC4: no fluid or mechanical compatibility risk
MFC5: check that hose/nozzle do not leak. Check hose inflation after unmasking hose inflation on calculator, with Vmin

EESC: Electronic/Electric/Software compatibility

EESC1: no EES compatibility risk
EESC2: no EES compatibility risk
EESC3: pulser and calculator shall have adequate compatibility for
- Checking the PC or technical data associated with the EC/TC for conformity of the pulser with the calculator

Module D: sampling, 1% of instruments
Module B: routine test, 100% of instruments
- Check if the transaction can start with the pulser disconnected (electrically)
- Reconnect pulser, start transaction
- Check if transaction will abort if pulser is disconnected during transaction
- Check accuracy of aborted transaction
- Reconnect pulser before next step

EESC4: display and calculator shall have adequate compatibility for
- Check PC or technical data associated to EC/TC for conformity of display with calculator
Module D: sampling, 1% of instruments
Module B: routine test, 100% of instruments
- Check if transaction can start with display disconnected (electrically)
- Reconnect display, start transaction
- Check if transaction will abort if display is disconnected during transaction
- Check accuracy of aborted transaction
- Reconnect pulser before next step
EESC5: check upstream manufacturing process of check valve and over pressure release valve versus design specifications. Check play and alignment of shafts between the pulser and meter. Sample test hose – "crunch", and check there is no impact on next delivery versus MPE.

7.3 Example for module D and F for Industrial Measuring Systems

Study case: Same IMS on trucks as described in paragraph 6.3, to deliver heating fuel to home. The system is using old (20 years old) technology (simple air-separator, reading pulses from pulser, the pulser driven by a vane meter, a calculator directly driving the display and a printer) for module D or F.

The following information is given as DELIVERABLE from MANUFACTURER to APPROVAL FOLDER and NOBO:

Module D or F	Vehicle power	Air separator	Meter	Pulser	Calculator	Display	Printer	Transfer point
Vehicle power	X	X	X	X	X	X	X	X
Air separator	X	X	MFC1	X	X	X	X	X
Meter	X	EESC1	X	MFC2	X	X	X	X
Pulser	X	X	EESC2	X	MFC3	X	X	X
Calculator	EESC6	X	X	EESC4	X	MFC4	X	MFC
Display	X	X	X	X	EESC4	X	X	X
Printer	X	X	X	X	EESC5	X	X	X
Transfer point	X	X	X	X	EESC7	X	X	X

The focus should be on the:

a) nature of the relationship (Mechanical+Fluid at top, Electrical/Software at bottom)
b) compatibility arrangement(s) **between the related components (sub-assemblies, parts) based on EC/PC/TC information if more than one is involved for any of the two components involved**
c) **nature of first verification test required (if any) to prevent risk**

MFC: Mechanical/fluid compatibility

MFC1: check piping arrangement / diagram and check module B versus each component for EC/PC/TC reference. Check fluid in use for instrument compatibility (versus components): viscosity. Check presence of anti-swirl or non-return valves. Check absence of interfering devices (air inlet)

MFC2: check that no mechanical interferences are possible to the shaft connection between meter and pulser

MFC3: no fluid or mechanical compatibility risk

MFC4: no fluid or mechanical compatibility risk

MFC5: adequate informative sticker or signal for driver, to empty hose at end.

EESC: Electronic/Electric/Software compatibility

EESC1: no EES compatibility risk
EESC2: no EES compatibility risk
EESC3: pulser and calculator shall have adequate compatibility for
- Check PC or technical data associated to EC/TC for conformity of pulser with calculator
Module D: sampling, 1% of instruments
Module B: routine test, 100% of instruments
- Check if transaction can start with pulser disconnected (electrically)
- Reconnect pulser, start transaction
- Check if transaction will abort if pulser is disconnected during transaction
- Check accuracy of aborted transaction

- Reconnect pulser before next step

EESC4: display and calculator shall have adequate compatibility for
- Check PC or technical data associated to EC/TC for conformity of display with calculator

Module D: sampling, 1% of instruments

Module B: routine test, 100% of instruments
- Check if transaction can start with display disconnected (electrically)
- Reconnect display, start transaction
- Check if transaction will abort if display is disconnected during transaction
- Check accuracy of aborted transaction
- Reconnect pulser before next step

EESC5: printer and calculator shall have adequate compatibility for
- Check PC or technical data associated to EC/TC for conformity of printer with calculator

Module D: sampling, 1% of instruments

Module B: routine test, 100% of instruments
- Check if transaction can start with printer disconnected (electrically)
- Check if paper fault detected
- Reconnect printer, start transaction
- Reconnect pulser before next step

EESC6: vehicle power and calculator shall have adequate compatibility for
- Check PC or technical data associated to EC/TC for conformity of power supply to calculator

Module D: sampling, 1% of instruments

Module B: routine test, 100% of instruments
- Check reaction of measuring instrument when engine is running and when engine is idle. Check reaction of measuring instrument when engine is started during a transaction
- Check diameter and adequateness of power connection(s) from vehicle to calculator, and specific power protection/cable layout requirements if any
- Check proper mounting (grounding) of calculator on vehicle chassis

EESC7: hose integrity to be checked. Nozzle tightness to be checked.