



Harmonisation of OIML R139, field data and proposition of suitable periods

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Overview

- OIML R139:2018
 - Situation in different countries
 - Why harmonise?
- Field test results
- Proposal on
 - verification procedure and
 - verification period
- Discussion ...

- New accuracy classes for Hydrogen
- Class 2 is preferred for new stations

5.2 Maximum permissible error (MPE)

5.2.1 Without prejudice to 5.2.3, the maximum permissible error on mass indications, positive or negative, is equal to the values presented in Table 1:

Table 1 - MPE values

Accuracy class		MPE for the meter [in % of the measured quantity value]	MPE for the complete measuring system [in % of the measured quantity value]	
			at type evaluation, initial or subsequent verification	in-service inspection under rated operating conditions
For general application	1.5	1	1.5	2
For hydrogen only	2	1.5	2	3
	4	2	4	5

- $MMQ = 1 \text{ kg}$, $E_{min} = 2 \times MMQ \times RMPE$ [g; kg]

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3 Type Evaluation

3.4.2 Test program

3.5.3 Measuring systems specific for hydrogen fuel

3.5.3.1 Tests 4 and 5 shall be performed at least three times on the complete system and test 7 shall be performed at least twice.

Each individual error shall not exceed the MPEs specified in R 139-1, 5.2 for the measuring system.

3.5.3.2 Preferably each test is performed consecutively under the same conditions or all of the tests are performed in a cyclic consecutive order (e.g. in the sequence # 4, # 5, # 7, # 4, # 5, # 7, # 4, # 5).

For Test 4 and Test 5, the requirement on repeatability specified in R 139-1, 5.4 shall be fulfilled.

5.4 Repeatability

For any quantity of the measurand equal to or greater than 1000 scale intervals of the meter, the repeatability error of the meter and of the measuring system shall not exceed two thirds (2/3) of the applicable MPE.

Table 9 - Test program

Test referred to by name	Test referred to			Applicable to meters	Applicable to measuring systems
	in sub clause	in table #	as test #		
Test(s) at variable flow rate	2.2.7.1	4	0	3 times ³⁾	
Test(s) with adjustable sequential control ¹⁾	2.2.7.2	5	1	n/a	3 times
Test(s) with sequential control	2.2.7.2	5	1	optional, 3 times	3 times
			2	n/a	3 times
			3	n/a	3 times
Test(s) without sequential control	2.2.7.3	6	4	3 times ²⁾	3 times
			5	3 times ²⁾	3 times
			6	n/a	3 times ²⁾
Test(s) on MMQ	2.2.7.4	7	7		twice ⁴⁾
Test(s) on durability	2.2.7.6	-	-	once	
Test(s) on preset function		-	-		once
Test(s) on gas influence factors	2.2.7.7	-	-	twice per influence factor	
Test(s) with flow disturbances etc.	2.2.7.8	-	-	If applicable, twice	If applicable, twice if not yet performed on meter

Not achievable with H2

? Includes zero-stability check

Note 1: Provided that the sequence of testing is clearly recorded, tests may be performed in a random order so as to minimize the total testing time and, for example, to allow for a full defueling overnight.

Note 2: Tests are mandatory unless otherwise specified (in the applicable subclause).

Footnotes:

¹⁾ Test at extreme (pressure) adjustment limits.

²⁾ Test is not applicable for hydrogen CGF measurement systems.

³⁾ For hydrogen CGF measurement systems the individual quantity values measured shall preferably be more than 1 kg. If this appears not feasible the test shall be executed applying 2 instead of 3 filling phases.

⁴⁾ This test is mandatory, when not yet covered by the test(s) at variable flow rate (Test # 0).

4.6.4 Tests to be performed

The testing procedure considered to be the ideal procedure is specified in 4.6.5. However, alternatively the **more practical procedure specified in 4.6.6 may be applied.** For hydrogen CGF measuring systems alternatively the procedure specified in 4.6.7 may be applied.

4.6.7 Alternative procedure for hydrogen CGF measuring systems

4.6.7.2 Tests 4 and 5 shall be performed at least three times on the complete system and test 7 shall be performed at least twice. Each individual error shall not exceed the MPEs specified in R 139-1, 5.4 for the measuring system.

4.6.7.3 Preferably each test is performed consecutively under the same conditions or all of the tests are performed in a cyclic consecutive order (e.g. in the sequence # 4, # 5, # 7, # 4, # 5, # 7, # 4, # 5).

For Test 4 and Test 5, the requirement on repeatability specified in R 139-1, 5.4 shall be fulfilled.

Test #	Initial state
3x Test 4	Initial test receiver pressure of 0 kPa or higher if so required for safety reasons Initial station storage pressure at P_{st} Full fill 2x
3x Test 5	Initial test receiver pressure of $0.5 P_v$ Initial station storage pressure at P_{st} Half fill 2x
2x Test 7 (minimum measured quantity)	The conditions for test 3 or 6 are adapted in order to test the minimum measured quantity. For this purpose, the pressure does not have to be P_v in the test receiver at the end, but may be any pressure (as close as practical to P_v) such that the quantity of transferred gas shall be at least the minimum measured quantity. MMQ

4.6.6 Alternative procedure

The tests are performed in conditions available in the refueling station...

Tests sufficiently representing the real conditions of use are performed. In general this condition is fulfilled when following the sequence:

- o filling the test receiver from empty to P_v ;
- o venting the test receiver to a pressure of $0.5 P_v$;
- o re-filling the test receiver from $0.5 P_v$ to P_v .

- This sequence provides two metrological results to be compared with the MPEs. Each applicable test is performed at least twice and as far as necessary to fulfill the requirement in the first paragraph of this sub clause.

- Each individual error shall fulfill the requirement on MPEs specified in R 139-1, 5.2.3.

4.6.7 is very time consuming - 2 days using gravimetric primary standards with type IV tanks

Good for type approval tests, initial verifications

-> make 4.6.6 to the preferred method for subsequent verifications

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5 Subsequent verification

For countries having a system of mandatory subsequent verification, an interval between verifications Exceeding 5 years is suggested. If during type evaluation the meter has not been subjected to the durability as specified in 2.2.7.6, it is suggested to set **the interval between the initial verification and the first verification not to exceed a 2 years' time period.**

The subsequent verification shall be carried out using suitable standards, of adequate accuracy. These shall be subjected to a suitable calibration program, assuring their traceability.

As a rule, the tests for subsequent verification shall be carried out on the complete instrument.

5.2 Tests at subsequent verification

5.2.1 Subsequent verification tests shall be carried out as specified in 4.6.

Two possible testing methods: 4.6.6 or 4.6.7

4.6.7 is very time consuming - 2 days using gravimetric primary standards with type IV tanks
-> make 4.6.6 to the preferred method for subsequent verifications

Current situation

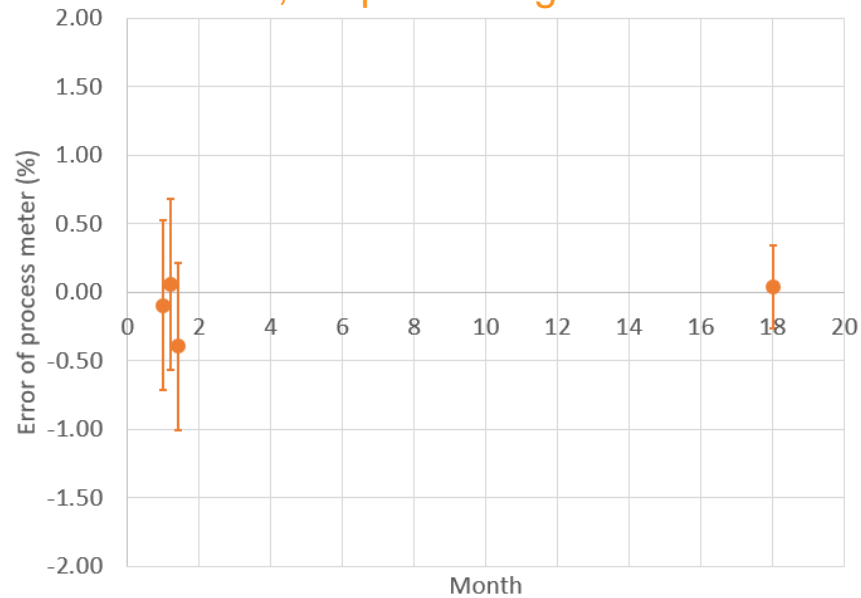
- Europe, Japan, Korea – no legal regulations for compressed hydrogen fuel
- Waiting for implementation into MID
- If national law was developed, it would be based on OIML R139
- Verifications for existing stations handled slightly differently – harmonisation is reasonable

	Austria	Switzerland, Sweden, Norway, UK	France	Korea
Number of public HRS	4(+1)	13, 4, 5, 19	44	149
Legal status	No „Eichvorschriften“ Reqs handled in type approval	no regulations	gov/metrology „La DM“ gives rules	no regulations
Type approval	3 full, 3 half, 2 MMQ	-	3 full, 3 half, 2 MMQ	
Initial verification	3 full, 3 half, 2 MMQ	-	3 full, 3 half, 2 MMQ	3 full, 3 half, 3 MMQ (research)
Subsequent verification	2 full, 2 half, 2 MMQ	-	3 full, 3 half, 2 MMQ	?
Verification period	2 years	-	1 year	?

Field tests

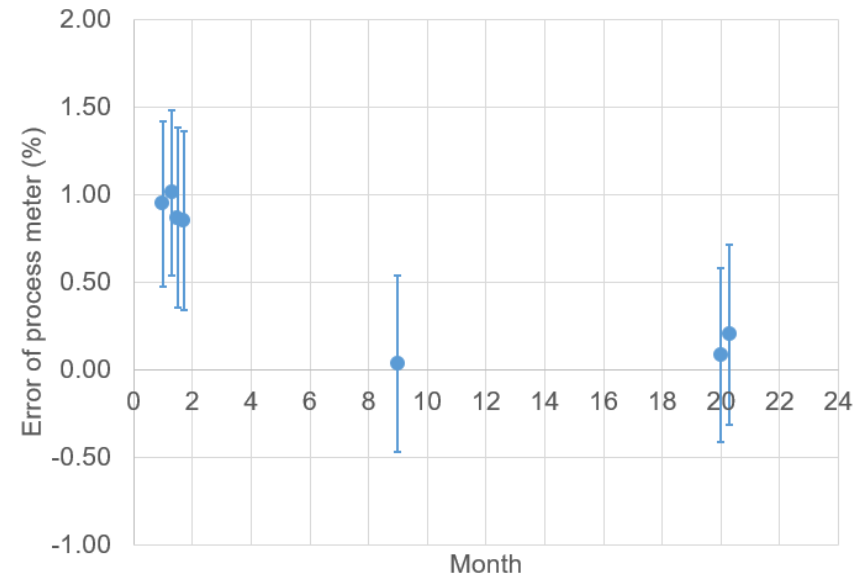
Monitoring measurements at 700 bar and 350 bar as part of MetroHyVe2

350 bar, no precooling



- Almost no drift over 1.5 years
- Maximum Permissible Error: 2 %
- Very limited data set
- Verification period of two years seems reasonable

700 bar, with precooling



- Drift of 0.7 % over 2 years
- Maximum Permissible Error: 2 %
- Meter seems to reach stable error
- Very limited data set
- Verification period of two years seems reasonable

Proposal

Reasonable to test a station more intensively

Action	Procedure	
Type approval	Tests according to 4.6.7	3 full fills, 3 half fills, 2 MMQ
Initial verification	Tests according to 4.6.7	3 full fills, 3 half fills, 2 MMQ
Subsequent verification	Tests according to 4.6.6	2 full fills, 2 half fills


Make 4.6.6 to the preferred method



Coriolis meter show stable behavior, low drift

Assumption: HRS does correct for dead volume, vented quantity, MFM located in dispenser

METROLOGY for HYDROGEN VEHICLES 2

 Bundesamt für Eich- und Vermessungswesen
Physikalisch-technischer Prüfdienst (PTP)


flow measurement services

 **Air Liquide**
creative oxygen


FROM RESEARCH TO INDUSTRY






French Designated Institute for high-pressure gas flow metering

 **EMCEL** Engineering Company for Fuel Cell Hydrogen Technology and Electric Mobility

 **Empa**
Materials Science and Technology

 **ITM POWER**
Energy Storage | Clean Fuel







 **SINTEF**




National Physical Laboratory







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THANK YOU

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3 Type Evaluation

3.5 Tests applicable to the measuring system

3.5.1 Measuring systems utilizing a sequential control device

3.5.1.1 Tests 1, 2 and 3 shall be performed on the complete system at least 3 times consecutively in the same conditions.

3.5.1.2 Test 7 shall be performed on the complete system at least twice.

3.5.1.3 If relevant and not already performed on the meter, specific tests (see 2.2.7.8) are performed.

If applicable, each test shall be performed twice.

Each individual error shall not exceed the MPEs specified in R 139-1, 5.2.1 for the measuring system.

3.5.1.4 For measuring systems that may be used with a sequential control device (incorporated or not) fitted with adjustment parameters, Test 1 shall be performed at least 3 times consecutively under the same conditions for each extreme value of the adjustment parameters.

When a parameter is tested, other parameters are at reference condition as specified by the manufacturer.

Each individual error shall not exceed the MPEs specified in R 139-1, 5.2.4 for the measuring system.

The requirement on repeatability specified in R 139-1, 5.4 shall be fulfilled.