

# 14<sup>th</sup> International EMATEM-Summer School

Gråsten, Denmark 19th to 21st September 2018

## *Recent problems in measurements of thermal energy and flow*

*Aktuelle Probleme der Wärmemengen- und Durchflussmesstechnik*

**Legal Measurement in the EU and Germany, WELMEC-Groups, Development of Technical Standardization**

**Gesetzliches Messwesen in Europa und Deutschland**

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- Overview about network of department Heat and Vacuum with its WG 7.51
- Motivations on 2018 EMATEM - lectures
- Economic globalization, conformity assessments and market surveillances
- Directive 2014/32/EU - MID and German law amended, for acceptance of foreign (EUC) verifications on cooling meters according to German § 28 MessEG
- German reducing “Sample size procedures” by tightening test conditions
- Adjustments in PTB Technical Regulations K 8, K 9 and K 19 as new AGME - authority issue
- Work items of planned standard revision EN 1434:2020

## Tasks for Working Group „Thermal Energy Measurements“

- Service and applied research for legal regulated measurements of*
- 1. thermal energy with heat and cooling meters, sub-assemblies*
  - 2. temperature surveillance of food suppliers with moveable electric thermometers (-25 °C to 40 °C)*

### Volume, Flow

6 l/h to 1000 m<sup>3</sup>/h  
3 °C to 90 °C

### Temperature Difference

3 K to 157 K Temp. Sensor Pairs  
5 °C to 160 °C Test setup bathes

### Calculators

3 K to 200 K, 0 °C to 200 °C  
6 l/h to 1000 m<sup>3</sup>/h electr. simulated



# Motivations – EMATEM, Gråsten 2018 lectures

## Recent developments with most importances

- I Legal metrology, standardization, test programs, conformity assessments  
*Messwesen, Normung, Prüfprogramme, Konformitätsuntersuchungen*  
- Mr. Rose, Kähler, Bombis, Holoch, Baack, Peetz, Sammler, Synáč, Mrs. Benková -
  
- II Measurement methods, measurement technology, field reports  
*Messverfahren, Messtechnik, Praxisberichte*  
- Mr. Peetz, Bott, Nau, Rademacher, Straka, Eichler, Buchin, Berns -
  
- III Test benches, measurement uncertainty, intercomparisons, settlement  
*Prüfstände, Messunsicherheit, Ringvergleiche, Abrechnung*  
- Mrs. Petrusha, Mr. Frahm, Wien, Mathies -

# Different Procedures of Evaluations acc. MID



<i>Courses of production done by manufacturer</i>	Kind of Procedure of Evaluation		
	Module B + F	Module B + D	Module H1
<i>Design</i>			Design Examination XXXXXXXXXXXXXXXX
<i>Pattern</i>	Type Examination	Type Examination	
<i>Series of Manufacturing Process</i>		QM-System of Production	Full QM-System
<i>Finalproduct</i>	product measurements		

! no defined limitation

Declaration of Conformity + CE-Label



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## Working Group Area

### About WELMEC Working Groups

Working Groups (WGs) are established by the WELMEC Committee for the detailed discussion of issues of interest and concern to WELMEC Members and Associate Members.

The document "Guidelines for Working Groups" contains information about the organisation within a working group.

[Guidelines for Working Groups](#)

Nominated contact persons of Working Groups can access restricted pages after login. For any questions, please contact the WELMEC Secretariat.

Working Group	Description	Convenor
<a href="#">Working Group 2</a>	Directive Implementation	Ivan Kriz
<a href="#">Working Group 5</a>	Metrological Supervision	Hermine van Rij Martin Glogovišek
<a href="#">Working Group 6</a>	Prepackages	Howard Burnett Deputy Convenor: Maria Loy
<a href="#">Working Group 7</a>	Software	Florian Thiel
<a href="#">Working Group 8</a>	Measuring Instruments Directive	Thomas Lommatzsch Deputy Convenor: Renée Hanssori
<a href="#">Working Group 10</a>	Measuring Equipment for liquids other than water	Marc Schmidt Deputy Convenor: Gašper Vindišar
<a href="#">Working Group 11</a>	Utility Meters	Kurt Rasmussen
<a href="#">Working Group 12</a>	Taximeters	Paul Kok Co-Convenor: Carol Paquier
<a href="#">Working Group 13</a>	Water and Heat Meters	Miroslava Benkova

# WELMEC 7.2, 2018

## Software Guide

Measuring Instruments Directive 2014/32/EU

### Technical Description

The scope of configurations, which are in suitable for a **software download**.

### Hardware Configuration

The instrument with facilities for a software download may be a built-for-purpose type (Type P) or an instrument with a universal computer (Type U). Communications links for the software transmission may be direct, e.g. RS 232, USB, over closed networks, e.g. Ethernet, token-ring LAN, over open networks, Internet.

### Software Configuration

The entire software to be downloaded may be legally relevant or there may be **a separation between legally relevant and legally non-relevant software**. In the latter case, only the download of legally relevant software is subject to the **requirements laid down below**. Download of legally non relevant software is allowed without any restrictions, provided the software separation has been certified.

## Abschnitt 6 Softwareaktualisierung

### *Neufassung MessEV*

#### § 40 Genehmigungsverfahren zur Aktualisierung von Software in Messgeräten

(1) Antragsbefugt sind

1. Wirtschaftsakteure oder
2. Verwender von Messgeräten.

#### *Conformity assessment at PTB:*

Dr. M. Esche, Dr. J. Rose

(2) Die Genehmigung kann für die Aktualisierung eines oder mehrerer Messgeräte bei der in § 40 Absatz 1 des Mess- und Eichgesetzes genannten Behörde beantragt werden.

(3) Die Genehmigung darf nur erteilt werden, wenn die nachfolgenden Voraussetzungen gegeben sind:

1. das Messgerät, für das die aktualisierte Software bestimmt ist,
  - a) ist konkret bezeichnet,
  - b) ist zur Aktualisierung von Software geeignet und die Eignung ist durch eine Konformitätsbescheinigung bestätigt, wobei dies insbesondere umfasst, dass
    - aa) die Aktualisierung der Software nach dem Beginn selbsttätig abläuft,
    - bb) durch informationstechnische Verfahren gewährleistet ist, dass die Software zur Aktualisierung aus einer autorisierten Quelle stammt und nicht verändert wurde gegenüber der in der Konformitätsbescheinigung genannten Software,
    - cc) Aktualisierungen und Aktualisierungsversuche der Software im Messgerät automatisch protokolliert werden und für einen Zeitraum von sechs Monaten nach Ablauf der Eichfrist gespeichert werden,
2. eine Konformitätsbescheinigung vorliegt, die die Übereinstimmung des mit der aktualisierten Software versehenen Baumusters des Messgeräts mit den wesentlichen Anforderungen im Sinne des § 6 Absatz 2 des Mess- und Eichgesetzes bestätigt und

## Europe : cooling meters regulated by individual national laws ...

13.8.2008

EN

Official Journal of the European Union

L 218/21

REGULATION (EC) No 764/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL  
of 9 July 2008

laying down procedures relating to the application of certain national technical rules to products lawfully marketed in another Member State and repealing Decision No 3052/95/EC

- (2) Obstacles to the free movement of goods between Member States may be unlawfully created by the Member States' competent authorities applying, in the absence of harmonisation of legislation to products lawfully marketed in other Member States, technical rules laying down requirements to be met by those products, such as rules relating to designation, form, size, weight, composition, presentation, labelling and packaging. The application of such rules to products lawfully marketed in another Member State can be contrary to Articles 28 and 30 of the Treaty, even if they apply without distinction to all products.

# Gesetz über das Inverkehrbringen und die Bereitstellung von Messgeräten auf dem Markt, ihre Verwendung und Eichung sowie über Fertigpackungen (Mess- und Eichgesetz - MessEG)

## § 28 Messgeräte, die rechtmäßig im Ausland in Verkehr gebracht wurden

(1) Messgeräte, die

1. nicht die CE-Kennzeichnung, die EG-Bauartzulassung oder die EG-Ersteichung erhalten können (e.g. **Cooling Meters**) und
2. in einem Mitgliedstaat der Europäischen Union oder einem Vertragsstaat des Abkommens über den Europäischen Wirtschaftsraum, in der Schweiz oder der Türkei rechtmäßig in Verkehr gebracht wurden, dürfen auch im Geltungsbereich dieses Gesetzes in Verkehr gebracht werden, wenn die Messrichtigkeit, Messbeständigkeit und Prüfbarkeit bei diesen Messgeräten in gleichwertiger Weise gewährleistet sind wie bei Messgeräten, die nach diesem Gesetz in Verkehr gebracht worden sind.

(2) Die nach Landesrecht zuständigen Behörden haben bei einer Prüfung der Gleichwertigkeit von Messgeräten im Sinne des Absatzes 1 die Vorschriften des Kapitels 2 der Verordnung (EG) Nr. 764/2008 des Europäischen Parlaments und des Rates vom 9. Juli 2008 (ABl. L 218 vom 13.8.2008, S. 21) zu beachten.

(3) Auf Antrag eines Wirtschaftsakteurs oder auf ein Ersuchen der nach Landesrecht zuständigen Behörde trifft die Physikalisch-Technische Bundesanstalt eine Entscheidung über die Gleichwertigkeit nach Absatz 1. Diese Entscheidung ist für die nach Landesrecht zuständigen Behörden verbindlich.

**Conformity assessment at PTB:**  
Dr. F. Renner, Dr. J. Rose

## WELMEC Working Group 5

<https://www.welmec.org/documents/guides/52/>



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# Recently tested heat meters ... with assessment by authority

Each of the six samples will be object of the following tests and exams:

- Formal checks/documentation control (see section 5.1 of WELMEC Guide 5.2).
- Check of the necessary seals and of the software version installed.

Laboratory testing of the following characteristics (see section 5.3 of WELMEC Guide 5.2)<sup>2</sup>:

- Detailed tests of every mentioned point see on EN 1434-4:2007:
  - o 6.4 Performance test (heat meter)
  - o 6.16 Static magnetic field (heat meter)
  - o 6.18 Internal pressure (flow sensor)
  - o 6.19 Pressure Loss (flow sensor)
  - o 6.21 24hrs interruption in supply voltage (calculator)

The test will be only done with complete devices (no subassemblies). Exceptionally, if all the complete devices that are present in one participant's market have being selected by other countries, it will be possible to choose combined heat meters).

6 types of the 18 tested heat meters failed one or more laboratory tests. For two of those types, all three samples failed the performance test (section 6.4 of EN 1434-4:2007). One out of three samples from four other types failed the performance test also. Two heat meters failed the internal pressure test (section 6.18 of EN 1434-4:2007) and one type failed the static magnetic test (section 6.16 from EN 1434-4:2007).

Also some formal non-conformities were found. With 5 of the tested types, the manufacturer did not provide the instrument with the Declaration of conformity. Also 5 types failed, because the markings of the type plate were not correct. Several times the units of measurement were missing on the plate.

In 12 cases, the information about how to read out the software version or to get the checksum was missing in the TEC. Nevertheless, several manufacturers included this information in the user manual, so it was possible for most Market Surveillance Authorities (MSA) to read out the software version and compare it with the TEC.

	Number	%
Types in the project	18	
Non-compliant instruments		
- Formal aspects	8	5,5 %
- Software aspects <sup>1</sup>	13	27,8 %
- Sealing aspects	1	5,5 %
- Functional aspects	6	38,9 %
- Other aspects	1	5,5 %

Table: Detected non-conformities (heat meters joint project)

The 18 tested types of heat meters are spread over 13 manufacturers. From 5 manufacturers 2 different types of heat meters were tested, and one type from the other 8.



JOINT PROJECT  
MARKETSURV MID  
AGREEMENT: 101/G/ENT/IMA/13/11212

Supported by the  
European Commission  
Directorate General  
Enterprise & Industry



(1)

## Protokoll

zweite Sitzung AGME-AA „Wärmezähler“ am 7.11.2017 - PTB Berlin

### TOP 11 Welmec WG 5, europäische Marktkontrolle, AGME-Einbindung, auffällige Wärmezähler

Untersucht wurden unter Federführung der AGME (ED NRW und Baden-Württemberg) auffällige Wärmezähler der Hersteller [redacted]. Es wurden falsch gelabelte Geräte im assoziierten EU-Bereich festgestellt. Messtechnische Untersuchungen zur anfänglich vermuteten unzureichenden Manipulationsfestigkeit gegen statische Magnetfelder ergaben nach Überprüfung des Testmagneten keine Auffälligkeiten. Druckverlustprüfungen ergaben bei bestimmten EAS bei Messkapselzählern Überschreitungen zur Norm EN 1434, aber nicht Konflikte mit der MID und MessEG/MessEV.

- Inspections of meters (proved to meet error limits in service) according to **statistic sampling schemes** allow fundamental conclusions about reliability
- Old regulation up to 2018: Ensuring compliance with 92 % of population done by sampling schemes after verification period is reached
- New regulation 2019: Requiring of compliance with 95 % of population which have to meet error limits during an outlook-prognosticated period (sampling schemes according to ISO 2859)
- Thus possibility of enlargement of added validity of verification period could be given

Inhalt

Überblick PTB-AK

§ 35

Stichprobenverfahren

Stichprobenpläne

Weiterentwicklung

**Altes Stichprobenverfahren**

- ▶ individuelle Fehlergrenzen
- ▶ 92% des Loses funktionstüchtig
- ▶ zum Prüfzeitpunkt

**§ 35: neue Regelung**

- ▶ Verkehrsfehlergrenzen
- ▶ 95% des Loses funktionstüchtig
- ▶ für Verlängerungszeitraum

---

⇒ Altes Verfahren:

- ▶ garantiert nicht per se Einhaltung der neuen Regelung
- ▶ für einige Bauarten möglicherweise ausreichend (wenn abgesichert durch Expertise im entsprech. Bereich)

⇒ Andernfalls neues Verfahren empfohlen

For different population sizes, sampling plans for the old regulation are listed (middle column, cf. [2, table D1]) ensuring a reliability of 92%. In addition, sampling plans according to the new regulation [9] and [10, tables 1, A1] are listed (right column) which ensure a reliability of 95% until the next inspection (when the extension period is half the verification period). The old sampling plans are also valid for the new regulation, when reliability decreases linearly with time, the measurement deviation is the only criterion to judge compliance, is normally distributed and the tightened specifications in table 2 are applied.

population size	sampling plan $(n, c)$ , acc. to	
	old regulation	new regulation
501 – 1200	(50,1)	(95,0)
1201 – 3200	(80,3)	(141,1)
3201 – 10000	(125,5)	(200,2)
10001 – 35000	(200,10)	(315,4)

**New sampling regulation has severe requirements on sample size  $(n)$  in comparison with assumption-criterion  $(c)$**

Submitted to: *Meas. Sci. Technol.*, 15 June 2017

Reducing Sample Size by Tightening Test Conditions

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Zählerbauart	Voraussetzungen	Verfahren, Stichprobenfehlergrenzen	Eichfristverlängerung in Jahren
Mechanische Durchflusssensoren mit Encodern ohne elektrische Hilfsenergie (z.B. Reed-Kontaktwerk), Rechenwerke, Temperaturfühlerpaare <u>sowie</u> elektronische Bestandsmessgeräte bis 31.12.2018, d.h. Gerätebauarten, für die nach früherer EO bis 31.12.2014 ein Stichprobenverfahren beschrieben war	keine 0/1 Ausfälle von Display, Batterie, Gebiete ähnlicher Wasserbeschaffenheit	Stichprobenanweisung Anhang 2 mit Stichprobenfehlergrenzen = $1/\text{Gamma} * \text{Verkehrsfehlergrenzen}$ gemäß Anhang 1, Tabelle 1	3 für DFS, WZ 5 für RW, drahtgewickelte und TFP in Schichttechnik mit > 70 mm Baulänge
neue elektronische Messgeräte mit elektrischer Hilfsenergie, gleicher Bauartzulassung, identischen Messverfahren, Bemessungsgrenzen, Prüfpunkten u.a., Gebiete ähnlicher Wasserbeschaffenheit	ohne bestandenes Qualifikationsverfahren und/oder kein Nachweis über lineares Ausfallverhalten und Messbeständigkeit	Stichprobenanweisung Anhang 3 mit Stichprobenfehlergrenzen = Verkehrsfehlergrenzen	2
neue elektronische Messgeräte mit elektrischer Hilfsenergie, gleicher Bauartzulassung, identischen Messverfahren, Bemessungsgrenzen, Prüfpunkten u.a., Gebiete ähnlicher Wasserbeschaffenheit	<u>Bestandenes Qualifikationsverfahren:</u> Nachweis der Messbeständigkeit durch von AGME anerkannte Nachweisführung über linear mit der Zeit die Spezifikationen einhaltende Messgeräte (VFG, keine 0/1 Ausfälle von Display, Batterie)	Stichprobenanweisung Anhang 2 mit Stichprobenfehlergrenzen = $1/\text{Gamma} * \text{Verkehrsfehlergrenzen}$ gemäß Anhang 1, Tabelle 2	halbe bzw. volle Eichfrist in Abhängigkeit von gewähltem $1/\text{Gamma}$ -Wert
	Diskussionsstand 29.5.2018: mathematische Ausarbeitung durch PTB mit Verbänden, beizubringende	messfehlerhistorisierte Belege	
weiterer Forschungsbedarf	datenbasiert-softwaregestütztes, attributiv verknüpfte Verfahren, PTB mit Herstellern und Verwendern	1. Schritt: Erfassung von Zähler- und Liegenschaftsdaten	individuell

## 4.2.2 Kurze Fühler mit einer Schutzrohrlänge bis 60 mm

In einer Übergangsphase bis zum 30.10.2026 dürfen konformitätsbewertete Temperaturfühler von Wärmehählern in Bestandsauchhülsen \*) verwendet werden, wenn sie durch eine zusätzliche Prüfung den Nachweis erbracht haben, dass sie die metrologischen Anforderungen bis zur Mediumtemperatur von maximal 110 °C erfüllen (siehe Veröffentlichung „PTB-Mitteilungen 119, Heft 4, Dezember 2009 „Einsatz MID-konformer Temperaturfühler für Wärmehählern in Bestandsauchhülsen“ sowie „Liste ausgesprochener Duldungen für Bestandsauchhülsen“ unter <https://www.ptb.de/cms/de/ptb/fachabteilungen/abt7/fb-75/ag-751.html>).

Merkmale der Temperaturfühler:

- Schutzrohr aus Edelstahl
- Messbeständigkeit nach der Norm EN 1434, Teil 4
- Messwiderstand nach EN 60 751 im Schutzrohr fest eingebaut, mit gutem thermischen Übergang. Als Messwiderstand kann z. B. Pt 100 oder Pt 500 eingesetzt werden.
- Einstelldauer  $\tau_{0,5}$  des Fühlers einschließlich Tauchhülse  $\leq 12$  s
- Durchmesser des Schutzrohres vorzugsweise 5,0 mm; 5,2 mm bzw. 6,0 mm
- Schutzrohrlänge der Fühler: 45 mm bis 60 mm

Merkmale der Tauchhülsen:

- für Druckstufe bis PN 25 mit Gewinde zum Einschrauben aus Werkstoffen Messing oder Edelstahl Nr. 1.4571 nach DIN 17 440 bzw. X6 Cr Ni Mo Ti 17-12-2 EN 10 088 ff.

*\*) Anmerkung:*

Sogenannte Bestandstauchhülsen sind solche Tauchhülsen innerstaatlich bauartzugelassener Temperaturfühler von Wärmezählern im Sinn der Eichordnung, Anlage 22 der ab 11.02.2007 geltenden Fassung, die nach Ende der Gültigkeit der Zulassung weiterhin im Feld bzw. in den Anlagen installiert sind. Diese innerstaatlich bauartzugelassenen Temperaturfühler bzw. Wärmezähler konnten mit den in den Bauartzulassungen aufgeführten Tauchhülsen im Rahmen der Übergangsvorschriften des Mess- und Eichgesetz spätestens bis 30. Oktober 2016 in den Verkehr gebracht und im Feld eingebaut werden. Mit der 4. Änderung der Eichordnung der Anlage 22 in der ab 13. Februar 2007 geltenden Fassung ist der Einbau von konformitätsbewerteten kurzen Temperaturfühlern von Wärmezählern bei der Neuinstallation, d.h. Neubau oder Austausch des Rohrabschnittes, in dem der Temperaturfühler eingebaut ist, für Nennweiten kleiner/gleich DN 25 in Tauchhülsen allerdings nicht mehr zulässig

## 5. Temperaturfühlereinbau

Um die Temperaturen möglichst genau zu erfassen, empfiehlt sich der direkte Einbau der Fühler ohne Tauchhülse.

Für Wärme-/Kältezähler mit Nenndurchflüssen kleiner/gleich  $q_p \leq 6 \text{ m}^3/\text{h}$  ist der Einbau der Temperaturfühler bei Neuinstallation des Rohrleitungsabschnitts im Bereich der Messstelle mit Nenndrücken kleiner/gleich 16 bar nur direkt eintauchend vorzusehen. Nur bei zu hoher Beanspruchung (z.B. Druck, Temperatur, Strömungsgeschwindigkeit, Schwingungen) können auch in diesen Fällen Fühler mit Tauchhülse eingesetzt werden.

Die Einbauart von Vor- und Rücklauffühlern muss identisch ausgeführt sein, es sei denn, der nicht-symmetrische Einbau ist zugelassen.

Es muss die Möglichkeit der Benutzersicherung gegen Manipulieren der eingebauten Fühler vorhanden sein.

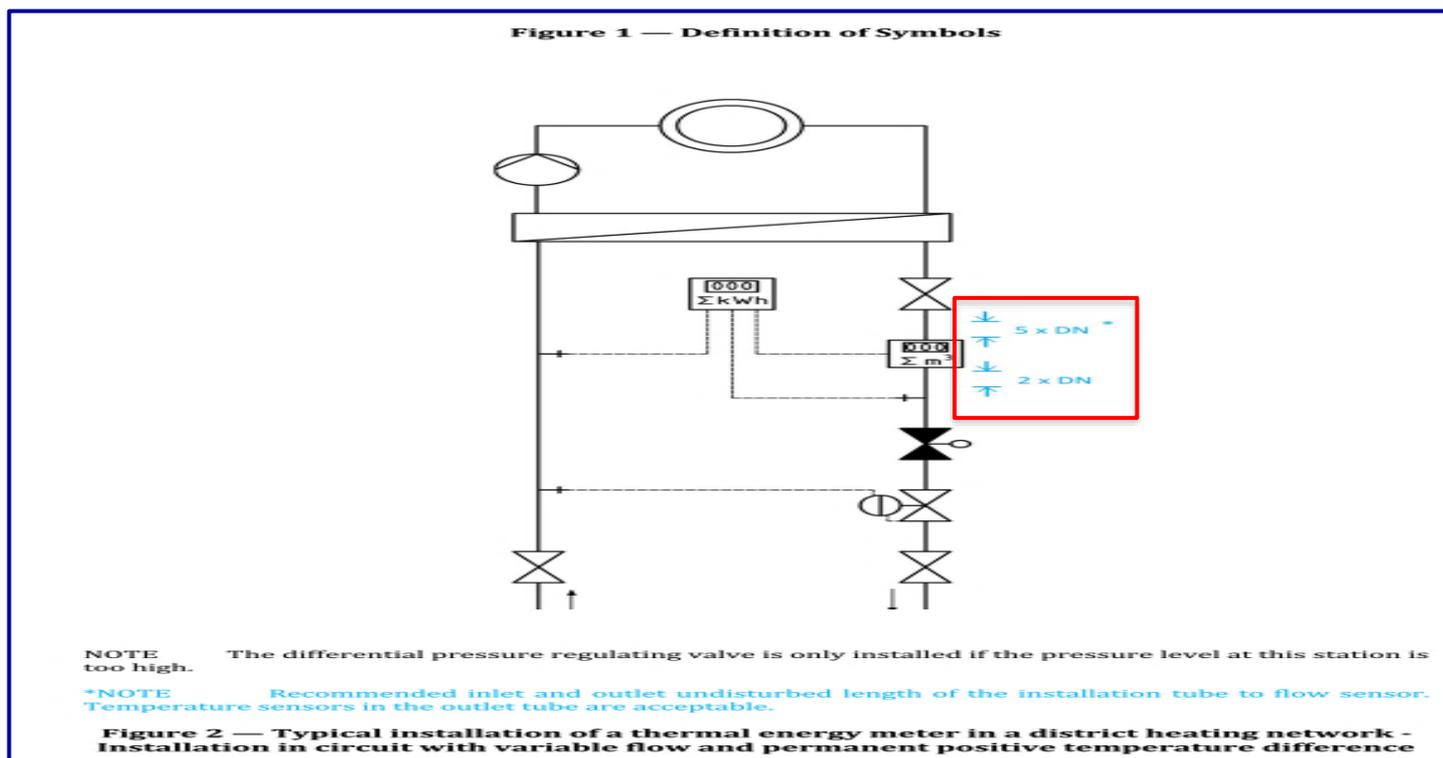
Die Fühler sind entsprechend den dargestellten Einbaubeispielen einzubauen.

Der Montageort muss einen einfachen Fühlerwechsel ermöglichen.

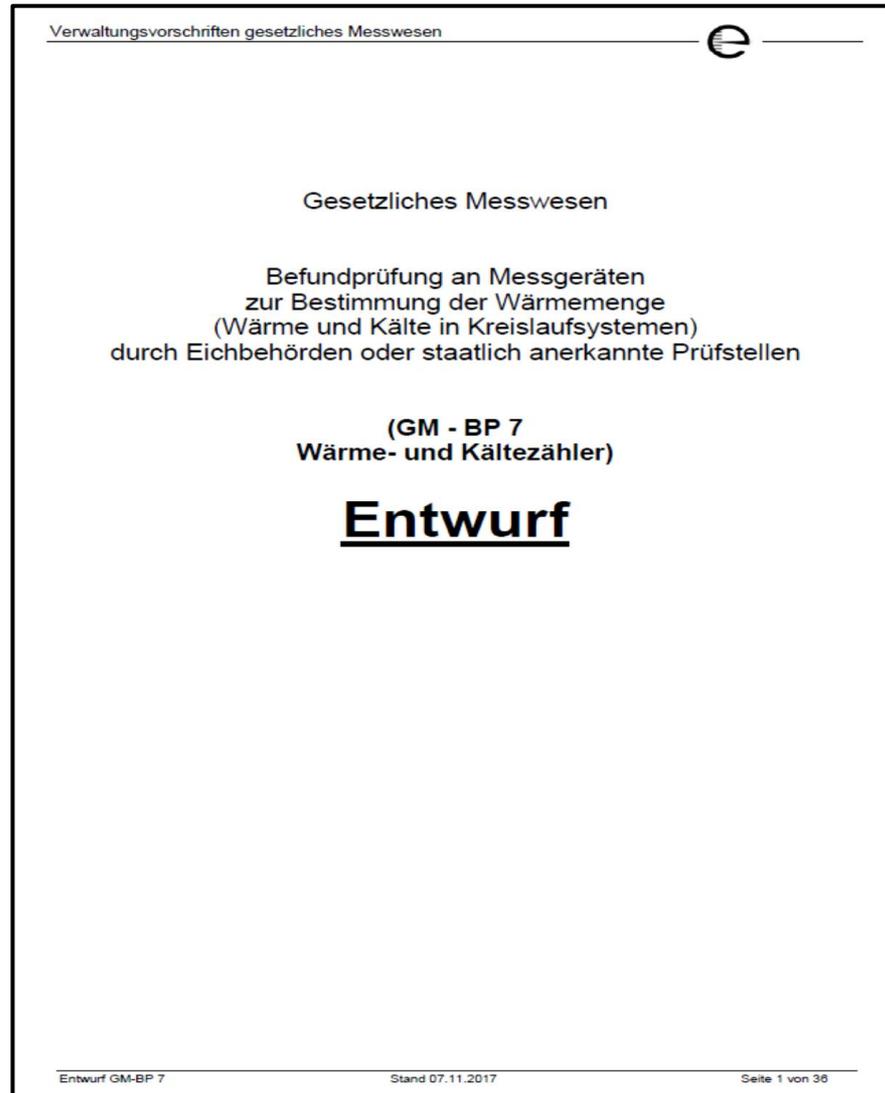
← without pockets in new installations !

## Status report

PTB WG „Heat Meter“ is ongoing with formulation for same „undisturbed inlet/outlet length“ according to planned revision of EN 1434:2020



# PTB TR K 19 as new German „regulation for diagnosis tests on suspect meters out of field“



## Discussion on Work Items for the next revision of standard in 2020

1. Complete clauses 12.4 "Maintenance instructions" and 12.5 "Hints for disposal instructions" of EN 1434-1 by instructions on how to separate different parts of meters before disposal
2. Clarify specifications for "Fast response meters", Annex C of 1434-1 "Define time based and volume based measurement principles.", for EN 1434-4 - description of test procedures (EN 1434-5 - nothing has to be done)
3. Test possibilities for testing complete meters in field: Clause 7a of EN 1434-2 (after the list) - add a requirement to make it possible to dismantle temperature sensors for testing the sensors itself in field, for EN 1434-4 and EN 1434-5 - test methods for complete meters without using of bathes
4. Clause 7.8.2.4 of EN 1434-4: A more than 10 year durability test - check if additional tests are necessary
5. Standardized user interactions and display indications (symbols) including error messages for commissioning of heat and cooling meters as informative annex
6. Clarification of state of the art in measuring energy using liquids other than water (e.g. water/glycol solutions)
7. Clarify if it's possible to make realistic recommendations for conditioning the test water for durability tests, source paper CEN/TC 176/WG 2 N 183
8. New clock wise swirl disturbance body instead of part 4, cl.7.22 - prevent instabilities of disturbance generation
9. Specific HF disturbance (induced e.g. by pumps, lamps, cell phones) in close proximity to the meter
10. Influences on performances coming by pumps, steps in tubes and conical valves
11. Revision of the CEN report "Installation of heat meters"

**REPORT from Convenor of Working Group 2 to the 23<sup>rd</sup> Meeting of CEN/TC 176 Heat Meter in Gothenburg on 14<sup>th</sup> September 2017**



**2.) Necessity for creation an amendment to the recent version of EN 1434:2015 as a harmonized standard to MID.**

This is caused by the new MID “Directive 2014\_32\_EU” which was released in European countries on 20<sup>th</sup> April 2016. So new “Annexes ZA” for all parts of standard were formulated, to harmonize the standard with the new MID. Additional to this, WG 2 suggested to rename the standard with reference to the new MID, now as “Thermal energy meters”. So the Amendment 1 has started for vote around the TC 176 members this year.

**Staus report:**

**finished by WG 2 TC 176, assigned to EUC, Off. Journal**



*Installation von Wärmezählern - Richtlinien für Auswahl, Installation und Betrieb von Wärmezählern*

**Installation of thermal energy meters - Guidelines for selection, installation and operation of heat meters**

Élément introductif – Élément central – Élément complémentaire  
Intended as replacement

- 1 Introduction .....
- 1.1 General .....
- 1.2 Explanation of designations .....
- 2 Selection of measuring instruments for thermal energy .....
- 2.1 General .....
- 3 Dimensioning.....
- 3.1 General .....
- 3.2 Determination of the heat output in the case of heat supply .....
- 3.3 Heat load.....
- 3.3.1 Design heat load in the case of newly constructed buildings.....
- 3.3.2 Heat load of buildings for which a calculation of the design heat load is not available .....
- 3.4 Heat capacity for domestic hot water heating .....
- 3.5 Heat output for ventilation and air conditioning systems .....
- 3.6 Heat output for technological purposes.....
- 4 Determination of the flow rate .....
- 4.1 Thermodynamic principles .....
- 4.2 Overall maximum heat output.....
- 4.3 Inlet and outlet temperature.....
- 4.4 Heat coefficient.....
- 5 Selection of a flow sensor for a thermal energy meter .....
- 6 Assessment of the design of the flow sensor after commissioning .....
- 6.1 Operating conditions.....
- 6.2 Flow sensors.....
- 6.2.1 General .....
- 6.2.2 Intake and discharge sections.....
- 6.2.3 Influences on measurement accuracy through insufficient temperature mixing.....
- 6.2.4 Measurement errors due to flow distortions from swirl.....
- 6.2.5 Measurement errors as a result of pulsations .....
- 6.2.6 Measurement errors due to the composition of the heat transfer fluid.....
- 6.2.7 Types of flow sensors.....
- 6.3 Temperature sensors.....
- 6.3.1 General .....
- 6.3.2 Measurement errors due to differential pressure and temperature difference.....
- 6.3.3 Use of thermal wells .....
- 6.3.4 Surface-mounted temperature sensor .....
- 6.4 Calculators .....
- 6.4.1 Mode of operation .....
- 6.4.2 Selection of calculators.....
- 6.4.3 Fast response heat measurement.....
- 7 Arrangement of the measuring instruments for thermal energy.....
- 7.1 Environment.....
- 7.1.1 Electromagnetic disturbances .....
- 7.1.2 Thunderstorm/voltage peaks.....
- 7.1.3 Temperature and humidity .....
- 7.1.1 Mechanical stresses .....

- 7.2 Flow sensors.....
- 7.2.1 Flow profile.....
- 7.2.2 Asymmetrical flow .....
- 7.2.3 Drall.....
- 7.2.4 Pulsation.....
- 7.3 Temperature sensor.....
- 7.3.1 General .....
- 7.3.2 Arrangement of temperature sensors .....
- 7.4 Calculators .....
- 8 Installation of the thermal energy meters .....
- 8.1 General .....
- 8.2 Mechanics.....
- 8.3 Connection to pipes .....
- 8.4 Electrical connection.....
- 8.5 Commissioning.....
- 9 Operation control .....
- 9.1 Measurement of the cooling supply with water or water-glycol mixtures .....
- 9.1.1 Requirement to be met by flow sensors with water-glycol mixtures.....
- 9.1.2 Requirement to be met by flow sensors with water-glycol mixtures.....
- 9.1.3 Requirement to be met by temperature measurement .....
- 9.1.4 Requirements to be met by the calculator .....
- 9.2 Requirement to be met by the system configuration of the cooling measurement...
- Bibliography.....

EN 1434-5:2015 6.4:

Heating applications:

$$c) \quad \Delta\theta_{\max} - 5 \text{ K} \leq \Delta\theta \leq \Delta\theta_{\max}$$

The outlet temperature shall be in the temperature range between  $(50 \pm 5) \text{ }^\circ\text{C}$  for heating applications and  $(15 \pm 5) \text{ }^\circ\text{C}$  for cooling applications, if not otherwise stated in the pattern approval certificate.

EN 1434-5:2015 Table 1:

Table 1 — Test temperature ranges

Test points	Test temperature range
$\theta_1$	$\theta_{\min}$ to $(\theta_{\min} + 10\text{K})$
$\theta_2$	$\frac{\theta_1 + \theta_3}{2} \pm 5\text{K}$
$\theta_3$	$\theta_{\max} \leq 150 \text{ }^\circ\text{C}$ $(\theta_{\max} - 10\text{K})$ to $\theta_{\max}$
	$\theta_{\max} > 150 \text{ }^\circ\text{C}$ $(\theta_{\max} - 20\text{K})$ to $\theta_{\max}$ but in any case more than $140 \text{ }^\circ\text{C}$

NOTE If specified in the pattern approval certificate, variations in the temperature ranges and the number of temperatures are permissible.

Typical calculators are designed for the following operating conditions:

$$\theta = 0 \dots 180 \text{ }^\circ\text{C}$$

$$\Delta\theta = 3 \dots 175 \text{ K}$$

Applying the definitions of 6.4 the inlet temperature results to  $(50 \pm 5) \text{ }^\circ\text{C} + 175 \text{ K} = (225 \pm 5) \text{ }^\circ\text{C}$ . But table 1 limits the inlet temperature to  $\theta_{\max} - 20\text{K}$  to  $\theta_{\max}$ . In addition to this the operation conditions of the calculator are exceeded.

Solution

Due to limitations in the operating conditions of the calculator the definitions according to table 1 are not always applicable. Therefore it is allowed to reduce the simulated outlet temperature  $\theta_{\max}$  or the maximum temperature difference  $\Delta\theta_{\max}$  until the operating conditions of the calculator are guaranteed.

... the elder version was good: bath fluid, extrapolation error, extrapolation range  
 -> have to meet MPE

### Extrapolation error of temperature sensor pairs

In the actual EN 1434-5 (2015) – version the third calibration temperature  $\Theta_3$  is defined as:

$\Theta_3$	$\Theta_{\max} \leq 150 \text{ }^\circ\text{C}$	$(\Theta_{\max} - 10 \text{ K})$ to $\Theta_{\max}$
	$\Theta_{\max} > 150 \text{ }^\circ\text{C}$	$(\Theta_{\max} - 20 \text{ K})$ to $\Theta_{\max}$ , but in any case more than $140 \text{ }^\circ\text{C}$

In the previous version EN 1434-5 (2007) this calibration temperature was defined as:

$\Theta_3$	For all $\Theta_{\min}$	$(\Theta_{\max} - 30 \text{ K})$ to $\Theta_{\max}$
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The reason for this changing was, that the uncertainty of the characteristic curve increases with the extrapolation range. Under this aspect the new definition was fixed without any additional consideration of the extrapolation error.

From the practical point it should be considered which fluids can be used in a thermostatic bath for the calibration. Below  $90 \text{ }^\circ\text{C}$  water is the best selection, but for higher temperatures the possibilities are limited. For temperatures below  $150 \text{ }^\circ\text{C}$  glycerin is recommended, but over  $150 \text{ }^\circ\text{C}$  another fluid shall be used (e.g. silicone oil). If glycerin is used as a standard fluid, for temperature probes up to  $180 \text{ }^\circ\text{C}$  another fluid shall be used. This leads to higher expenses and is uneconomical for many test centers.

Further calculations show, that the extrapolation error for a temperature pair rises at  $\sim 20 \text{ mK}$  between  $20 \text{ K}$  and  $30 \text{ K}$ . On the other side in the temperature range over  $100 \text{ }^\circ\text{C}$  the measured differences are higher than  $10 \text{ K}$ , which means, that the MPE is also increased.

For example: For a temperature difference of  $40 \text{ K}$  the MPE is  $290 \text{ mK}$ . The allowed tolerance is significant higher compared to the additional extrapolation.

From this viewpoint and under consideration of the practical advantage (only one fluid can be used.) the extrapolation range should be re- changed from  $20 \text{ K}$  to  $30 \text{ K}$  as before.

The new calibration temperatures shall be defined as following:

Test points	Test temperature range	
$\Theta_1$	$\Theta_{\min}$ to $(\Theta_{\min} + 10 \text{ K})$	
$\Theta_2$	$\frac{\Theta_1 + \Theta_3}{2} \pm 5 \text{ K}$	
$\Theta_3$	$\Theta_{\max} \leq 150 \text{ }^\circ\text{C}$	$(\Theta_{\max} - 10 \text{ K})$ to $\Theta_{\max}$
	$\Theta_{\max} > 150 \text{ }^\circ\text{C}$	$(\Theta_{\max} - 30 \text{ K})$ to $\Theta_{\max}$ , but in any case more than $140 \text{ }^\circ\text{C}$

NOTE If specified in the pattern approval certificate, variations in the temperature ranges and the number of temperatures are permissible.

-> see special lecture of this meeting !

## Annex C (normative) Fast response meters

A meter or sub-assembly defined as "Fast response meter" shall have at least the following additional specifications

- Response time ( $\tau_{0,5}$ ): max. 6 s for long temperature sensors; max. 2,5 s for short temperature sensors
- For battery driven meters the time between measuring samples (flow and temperature) and as well as incremental energy calculations: for time interval based measurement 8 s are recommended. For volume quantum based measurement  $8 \text{ s} * q_p/q$  or by equivalent volume fraction are recommended.
- For meters driven by mains the time between measuring samples (flow and temperature) and as well as incremental energy calculations: for time interval based measurement 4 s are recommended. For volume quantum based measurement  $4 \text{ s} * q_p/q$  or by equivalent volume fraction are recommended.

# The asymmetric swirl disturbance generator: Towards a realistic and reproducible standard

**kamstrup**



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<sup>d</sup>Kamstrup A/S, Industrivej 28, Skanderborg, Denmark



Figure 1: Standardized clockwise swirl disturbance generator (a) and the novel asymmetric swirl disturbance generator used in the experiments (b).

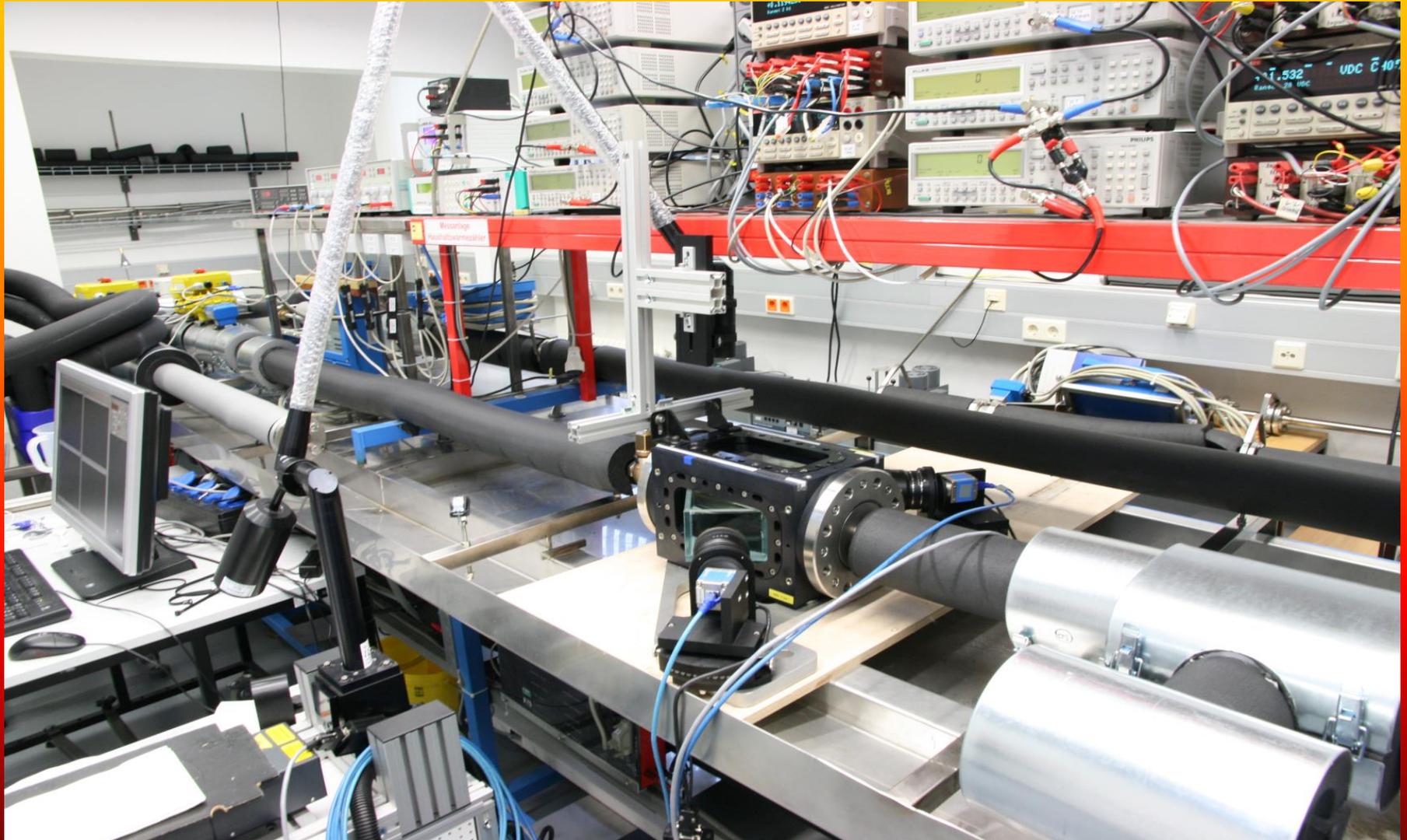
## Abstract

Flow meters are exposed to very disparate and usually adverse flow conditions produced by the pipe configuration at the installation location. These so-called installation effects may affect the accuracy of the flow measurement. Within performance tests of water, heat, and cooling meters at flow laboratories, a selection of such installation effects are emulated by standardized disturbance generators. In particular, the standardized swirl disturbance generator is designed to reproduce the flow conditions downstream from a double-bend out of plane, a common installation in realistic pipe networks. However, recent studies suggest that tests with standardized swirl disturbance generators might not be sufficiently reproducible due to instabilities generating random flow patterns downstream. Here, we analyze the flow profile generated by a novel asymmetric swirl disturbance generator using laser-Doppler velocimetry. Our results suggest that the asymmetric swirl disturbance generator produces flow disturbances with similar features as those downstream from a double-bend out of plane. In consequence, the asymmetric flow disturbance generator is a good candidate for more reproducible and realistic tests of installation effects at flow laboratories and shall replace the actual swirl generator in the standards.

-> see special lecture of this meeting!



# Laser Profile measurements with PIV



-> see special lectures of this meeting !



## Definition of international accepted Enthalpy Coefficients (k-factors)

**40 different solutions** detected in practice of fields, e.g. Ethylen-G, 1,2 Propylen-G, 1,3 Propylen-G, Butan-G with ingredients of Carboxyl acid, Tetra-Flour-Ethan, Potassium, Silicate, Hydrazin with

- different concentrations and combinations thereof
- different ages

Temperature range  $-20\text{ }^{\circ}\text{C}$  to  $110\text{ }^{\circ}\text{C}$ , Pressure 4 bar

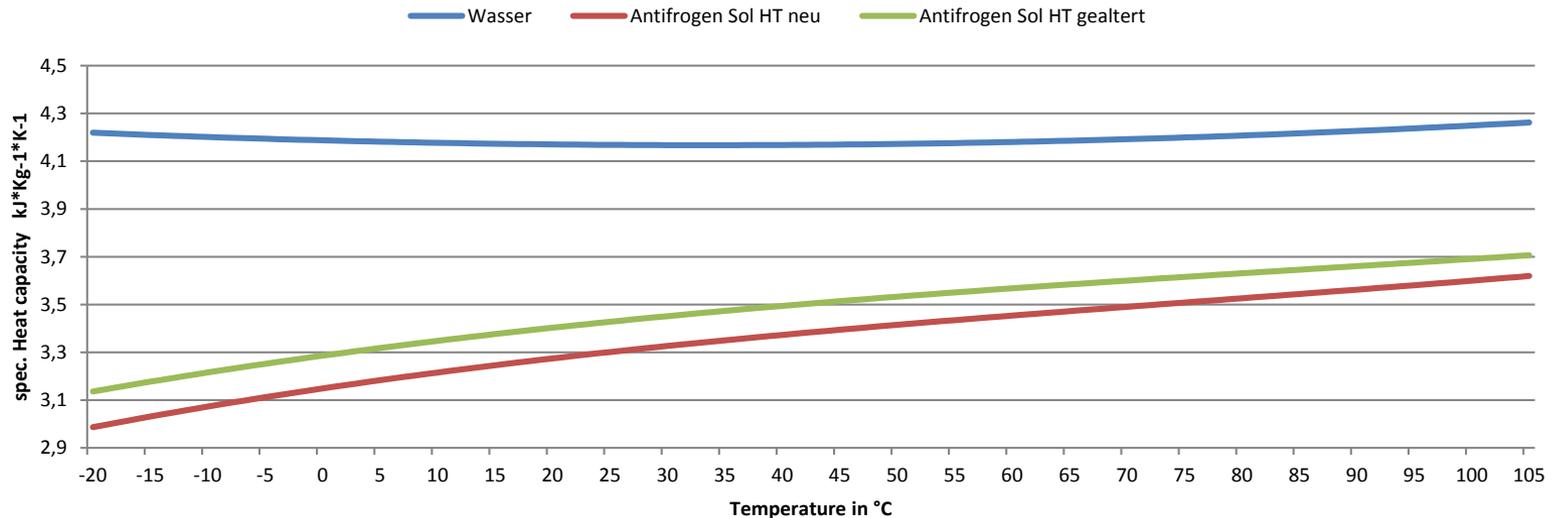
Measurements of calorimetric density, specific thermal capacity, viscosity and acoustic elapse time to ensure Ultrasonic Flow Sensor's accuracy, durability and aging effects of medium



Volumetric Prover enables testing of 5 flow sensor's accuracy

# Change of physical properties on aged (tempered) mixtures

- clouding, flocculation
- pH-value is decreasing
- change of specific heat capacity up to 6 % depending on mixture and temperature



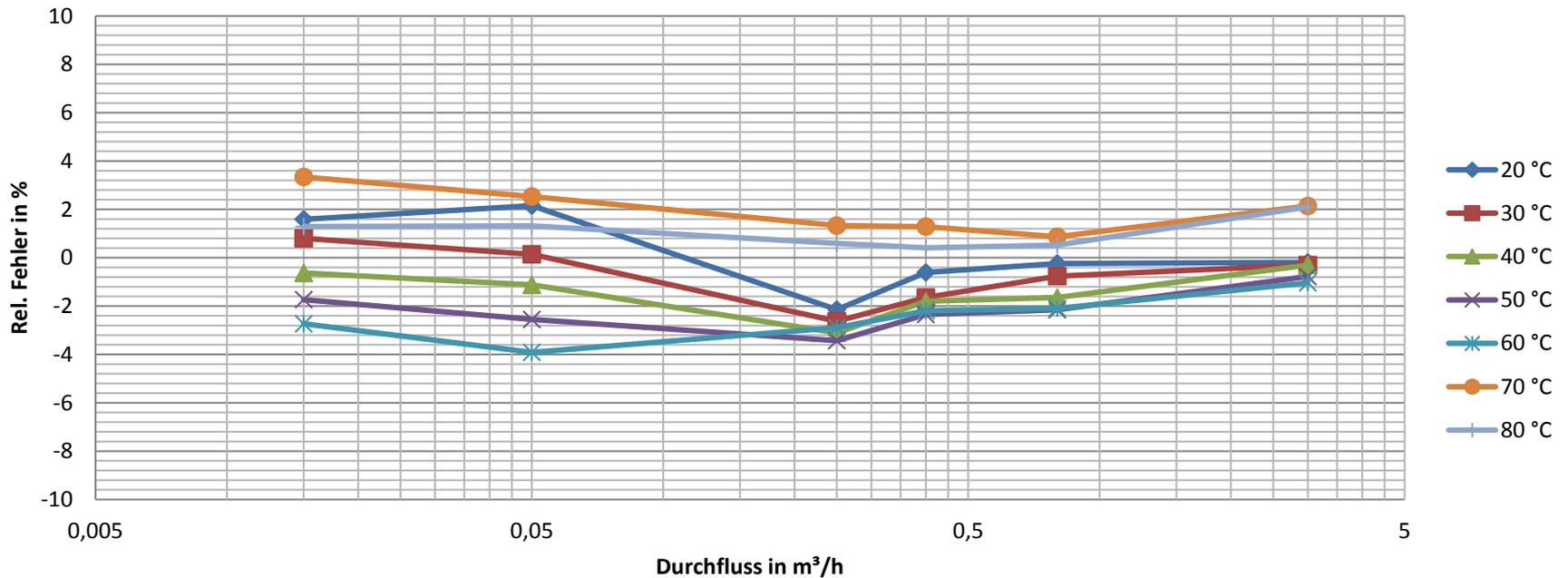
- Aging: chemical analyses on real mixtures coming from field

# Water-glycol solutions

- Adapted Ultra sonic flow sensor on specific water-glycol mixture

## Tyfocor L 40 %

Note: error curves depending on kind of mixture and temperature



Proposal by Mr Lang to the "Draft Minutes of the meeting in Berlin on 2016-11-02/03 CEN/TC 176/WG 2 (N 577), item 4.2.10 "Disturbance interferences caused by frequency fields close to heat meter due to pumps, mobile phones etc."

Mr. Lang suggests that CEN/TC 176/WG 2 uses the below final draft as the technical background, if there should be initiated a new type test in pending prEN 1434-4:2020 regarding EMI/EMC in the frequency range 9...150 kHz. ←

**New WI:**

**Low frequency testing**



**77B/769/FDIS**

FINAL DRAFT INTERNATIONAL STANDARD (FDIS)

PROJECT NUMBER:

IEC 61000-4-39 ED1

DATE OF CIRCULATION:

2016-12-23

CLOSING DATE FOR VOTING:

2017-02-03

SUPERSEDES DOCUMENTS:

77B/751/CDV,77B/759A/RVC

## 7.13 Electromagnetic field caused by digital radio wireless equipment

### 7.13.1 Electromagnetic field in distant proximity

No significant fault shall occur during the test.

The complete thermal energy meter and the sub-assemblies calculator and electronic flow sensor and its external cables of at least 1,2 m length shall be subjected to radiated RF fields of the frequencies 900 745 MHz and 1-800 to 5785 MHz under the conditions given in Table 15.

Reference to standard: EN 61000-4-3 and EN 60601-1-2

**Table 15 — Test conditions**

Environmental class	A	B	C
Frequency		800 745 MHz to 960 MHz 1-850 MHz to 2-700 5785 MHz	
Test level	10 3 V/m	10 3 V/m	30 10 V/m
Modulation	AM (1 kHz) 80 %	Pulse modulation 217 Hz, 50% duty cycle	

The preferred transmitting antennas are a log-periodic antenna or a low-directional horn antenna.

The test shall be performed sequentially with the antenna polarized in two orthogonal positions.

The frequency ranges shall be stepped as below. The dwell time at each frequency shall be not less than the time necessary for the thermal energy meter or the sub-assemblies to carry out a RVM measurement and to respond.

The tests shall be carried out in steps, using the following frequencies in MHz:

800 850 900 950 1-750 1-850 1-950 2-400 2-700  
745 810 870 930 1720 1845 1970 2450 5240 5500 5785

Determination of the intrinsic error at RVM condition shall be commenced at the start of each exposure and terminated at the end of each exposure. No significant faults shall occur.

If the thermal energy meter or the sub-assemblies has a standardised data output, the intrinsic error shall also be determined using this data output. During the test the master shall send requests at intervals of 30 s to the meter. The meter shall respond within 3 requests

**NOTE** Thermal energy meters using the protocol according to EN 60870-5 answer with at least the minimum protocol, thermal energy meters the protocol according to EN 62056-21 answer with an identification and a data message.

### 7.13.2 Electromagnetic field in close proximity

No significant fault shall occur after the test.



The complete thermal energy meter and the sub-assemblies calculator and electronic flow sensor and its external cables of at least 1,2 m length shall be subjected to radiated RF field, as a transient phenomenon, under the conditions given in Table xx.

Reference to standard: EN 61000-4-3, EN 61000-4-39 and EN 60601-1-2

Note: The test setup could be either TEM horn antenna used in according to IEC 61000-4-39 or alternatively an appropriate log-periodic antenna used in according to IEC 61000-4-3, in a distance reduced to 1 meter.

Table xx — Test conditions

Environmental class	A	B	C
Frequency	810, 870, 930, 1720, 1845, 1970 MHz		
Test level	100 V/m		
Modulation	PM: 217Hz, Pulse modulation, 50% duty cycle		
Antenna orientation	Horizontal and vertical		
EUT orientation	0, 90, 180, 270 degrees		

The frequencies shall be stepped. The dwell time at each frequency shall be not less than the time necessary for the meter to carry out a RVM measurement.

The frequency ranges shall be stepped. The dwell time at each frequency shall be not less than the time necessary for the thermal energy meter or the sub-assemblies to carry out a RVM measurement.

All frequencies is to be exposed in all combinations of horizontal, vertical antenna orientation, and: 0, 90, 180, 270 degree EUT position.

As a result, it adds up to a sequence containing 48 exposures all at 100V/m field strength.

Before the complete test sequence of exposures, an intrinsic error determination at RVM measurement shall be carried out.

After the complete test sequence of exposures, it shall be examined that no information or any readings are changed due to the exposures, but the figure of the lowest significance of the readings for heat or cooling quantity may alter by one unit at most.

An intrinsic error determination at RVM measurement shall be carried out and no significant faults shall occur. If the Utility meter under test has a standardized data output, intrinsic error shall also be determined using this data output.

The meter shall be switched on during the test with a flow rate of zero and  $\Delta\theta = \Delta\theta_{RVM}$ .



# 14<sup>th</sup> International EMATEM-Summer School

Gråsten, Denmark 19th to 21st September 2018

## *Recent problems in measurements of thermal energy and flow*

*Aktuelle Probleme der Wärmemengen- und Durchflussmesstechnik*

**Legal Measurement in the EU and Germany, WELMEC-  
Groups, Development of Technical Standardization**

**Gesetzliches Messwesen in Europa und Deutschland**

**Dr. Jürgen Rose**  
**Fachbereich Wärme und Vakuum**  
**[juergen.rose@ptb.de](mailto:juergen.rose@ptb.de)**

