EURAMET TC - Flow

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TC-F Chair
EURAMET

The European Association of National Metrology Institutes (EURAMET) is a Regional Metrology Organisation (RMO) of Europe. It coordinates the cooperation of National Metrology Institutes (NMI) of Europe in fields like research in metrology, traceability of measurements to the SI units, international recognition of national measurement standards and related Calibration and Measurement Capabilities (CMC) of its members.
Traceability Chain

BIPM
(Bureau International des Poids et Mesures)

National metrology institutes or designated national institutes

Calibration laboratories, often accredited

Industry, academia, regulators, hospitals

End users

The national metrological infrastructure

DEFINITION OF THE UNIT

FOREIGN NATIONAL PRIMARY STANDARDS

REFERENCE STANDARDS

WORKING STANDARDS

MEASUREMENTS

 UNCERTAINTY INCREASES DOWN THE TRACEABILITY CHAIN
EURAMET and the TCs

The technical collaboration in EURAMET is organised within 12 Technical Committees (TC):

- Acoustic, ultrasounds and vibrations
- Electricity and magnetism
- Flow
- Ionizing radiation
- Length
- Mass and related quantities
- Metrology in chemistry
- Photometry and radiometry
- Thermometry
- Time and frequency
EURAMET and the TCs

- The TCs are the forum for scientific and technical cooperation in the respective fields.
- The TCs are responsible for the execution of the activities required by EURAMET as Regional Metrology Organisation for the fulfillment of the Mutual Recognition Arrangement of the International Committee of Weights and Measures (CIPM-MRA).
The technical committee for flow (TC-F) is concerned with the issues which are important to industry, regulation and trade involving the measurement of fluid quantity and related measurements derived from it (e.g. energy).

The measurement of fluid quantities focuses on the measures of water, hydrocarbon liquids, air and natural gas, other fluids and mixtures of fluids. Also the fluid speed is under the scope of this TC.
TC-F STRUCTURE

Meet every year with the purpose of knowledge transfer and cooperation between NMIs that are working in flow measurements

Three formal sub groups
- Gas Flow – Convenor - Bodo Mickan from PTB
- Liquid Flow - Convenor - Petra Milota from BEV
- Volume and proprieties of liquids - Convenor - Zoe Metaxiotou from EIM

New SC in fluid speed is under approval
MEMBERSHIP

- 29 contact persons
- 52 flow experts
- 33 EURAMET members organizations:
  - 10 DI
  - 21 NMI
  - 2 others
TC-F Work

- Projects (comparisons)
- CMC
- R&D
- Guides
EURAMET and BIPM Comparisons

- In order to support the calibration and measurement capabilities (CMC) declared by the NMI and DI in the frame of the CIPM-MRA, comparisons are performed in a regular base.
- Then users and manufactures can have a guaranty of traceable calibrations to the SI.
EURAMET PROJECTS IN FLOW

- Total 71
  - Gas flow (high and low pressure) – 29
  - Liquid flow (water and hydrocarbon) – 27
  - Volume – 15

We need to have sponsors from industry for our comparisons with flow meters because NMI are not have enough funds for this type of work.
1000 L proving tank comparison

Official results with reference value

NMI

- Volume
- Vref
- Uref
TC-F CMC up to 2006

nr entries per NMI

- 504 in 2002
- 375 in 2003
- 333 in 2005
- 270 in 2006

nr entries

Austria  Belgium  Bulgaria  Czech  Denmark  Finland  France  Germany  Greece  Hungary  Italy  Lithuania  Netherlands  Norway  Poland  Portugal  Slovakia  Spain  Sweden  Switzerland  Turkey  UK

nr entries per NMI

504 in 2002
375 in 2003
333 in 2005
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## TC F CMC Published in 2012

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EMRP (R&D in EUROPE)

- The European Metrology Research Programme (EMRP) enables European metrology institutes, industrial organizations and academia to collaborate on joint research projects within specified fields.
- EMRP was implemented in 2009 by EURAMET and counts actually with 22 members National Metrology Institutes (NMIs).
- This project is running under the 7th Framework program of the European Commission and has a value of 400 M€.
EMRP TC-F participation

- Call 2009 - Energy
  - ENG03 - Metrology for Liquefied Natural Gas
  - ENG06 - Metrology for Improved Power Plant Efficiency
  - ENG09 - Metrology for Biofuels
- Call 2011 - Health
  - HLT07 - Metrology for drug delivery
MeDDD project

- Millions of people depend on drug delivery, in Europe:
  - Approximately 60 million people suffer from diabetes
  - About 10,000 people use mobile drug delivery devices
  - 5 to 9% of all births are preterms
  - Multi-pump infusion is now widely used

- The calibration services in Europe go down to a flow rate of approximately 10 µl/min with an uncertainty of 4% and have not been validated below flow rates of 100 ml/min. For flow rates lower than 10 µl/min, there are currently no standards available.
MeDD project

- Development of flow meter for low to ultra-low flow rates (based on gear pump or syringe)
- Characterization of commercial flow meters and drug delivery devices used in the range of microflow
- New primary flow rates from 1 to 100 nl/min, target uncertainty better than 0.5%
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EMPIR

- The new EURAMET research program EMPIR (European Metrology Program for Innovation and Research) is under preparation. Start in 2014
- Similar structure than EMRP along:
  - Exploiting and serving basic science related to metrology
  - Advanced metrology meeting the grand challenges, energy, environment and health
  - Innovation
  - Including capacity building
## TC – F Roadmap 2012-2020

### Triggers/Drivers/challenge

- Improved micro & nano flow meas. in health
- Improvement in meas. techniques for enhanced industrial efficiency
- Optimization and reduction of energy consumption
- Improvement of emissions & waste monitoring techniques
- Basic Science for reduced uncertainty in traceability chains

### Target/Impact KT

- Innovative metrological tools for biomedical traceability
- Development and improvement of cost-effective complex flow measurements
- Improved control and enhanced metering of energy-carrying fluids
- Developm. of traceable meas. techn. for emission/waste reduction, monitoring and trade
- New fundamental standard for absolute molecule counting

### Deliverables

- New regulations and guidelines
- Traceable drug delivery devices
- Characterization of biological flows
- Extrapolation of standard calibrations to non-ideal conditions
- Improved traceability for smart grid management
- Intern. Regulations for industrial emissions, waste management and their trade
- Intercomparisons and evaluation of final uncertainty

### Technologies

- Reference Standards for measurement of new fluids
- Feasibility study of gas mol counting/ MHD generator
- Innovative metering technology for complex fluids
- Updated regulations for urban pollution
- Gas mol counter & transfer methods

### Enabling science

- Measurement principle with traceability to A and mol
- Primary standards for micro/nano flow
- Feasibility study of gas mol counting/ MHD generator
- Optimized gas flow ionization
- Traceable industrial pollution metering techniques

### Flow

- Micro/nano flow instruments and pumps
- Complex fluids metering, modeling and analysis techniques
- Internal treaties, policies and existing guidelines
- Harmonized traceability & measurement techniques for single phase fluids

### Technologies

- Micro-flow generators, particle tracking velocimetry and CFD in biological flows
- Flow simulation, pilot facilities, advanced measurement techniques
- Measurement and modeling of complex flows
- Velocity profile, single/multiphase, flow meas. techniques & CFD tools

### Enabling science

- Micro/nano flow instruments and pumps
- Complex fluids metering, modeling and analysis techniques
- Internal treaties, policies and existing guidelines
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R&D

- Need Industry to take part and support this research and development proposals
- Need to have more interaction with users and manufacturers
TC-F EURAMET Guides

- Published

- Concluded and waiting for publication
  - EURAMET Guide nº 21 - Guidelines on the calibration of standard capacities measures using the volumetric method

- In development
  - Harmonization of the uncertainty budgets and calibration methods for liquid flow standards

www.euramet.org
The WGFF is the working group for fluid flow in the BIPM committee of Mass and related quantities.

Among other issues its involved in the harmonization and development of documents in the scope of CIPM-MRA.

The latest approved document in February 2013 is the Guidelines for CMC Uncertainty and Calibration Report Uncertainty.
WGFF guidelines on uncertainty

- WGFF Guidelines for CMC Uncertainty and Calibration Report Uncertainty motivations:
  - Clarify our common understanding
  - Fitting our practice to the politics of CIPM+ILAC
  - Define simple rules
  - Distinguish clearly between CMC-uncertainty and uncertainty reported in a calibration certificate (performance indicator)

\[
U_{CMC} = k_{95} u_{CMC} = k_{95} \sqrt{u_{base}^2 + u_{repeat, BED}^2}
\]
WGFF guidelines on uncertainty

\[ U_{PI} = 2u_{PI} = 2\sqrt{u_{base}^2 + u_{Al}^2 + u_{prop}^2 + u_{repeat or reproducibility, DUT}^2} \]

- PI: Performance indicator (pulse factor, discharge coefficient...)
- Additional sources of uncertainty have to be considered (associated instruments, fluid properties and other as they are applicable).
- Repeatability of BED is replaced by repeatability (reproducibility) of specific DuT.
- The absolute MUST: UPI ≥ UCMC
Flow measurements in daily life

- A tenth of a percent can be hundreds of million Euro lost if you are on the wrong side of the measurement.
- The annual consumption of petrol in Portugal is 1,2 Mm$^3$.
- According to our legislation the maximum permissible error (MPE) in the verification of fuel pumps is 0,5 %.
- If we consider the price of 1,6€/L the MPE corresponds to 10,4M€.
Thank you for your attention!!

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