



## 1. General Aspects

The Technical Committee for Flow (TC-F) is concerned with issues that are relevant to industry, regulation and trade involving the measurement of fluid quantity and fluid speed and related measurements derived from it (e.g. energy). The measurement of fluid quantities focuses on the measurements of water, hydrocarbon liquids, air and natural gas but also includes all other fluids and mixtures of fluids.

The first TC-F meeting was held in East Kilbride in 1988 with less than 10 participants. 50 members from 30 different countries attended the last TC-F meeting which was held in Funchal in May 2018. The TC-F community increases and, at the moment, there are 29 contact persons and about 90 flow experts involved.

The TC-F members are very active in the development of flow research facilities but also in facilities for type approval and support for legal metrology in their respective countries. Routine work for industrial and laboratory customers is also a big part of this community.

Furthermore TC-F is a type A liaison for the following organizations:

- ISO/TC 48 for the revision of the ISO 8655 (micropipettes)
- ISO/TC 28 for the revision of ISO 8222
- OIML TC8 – Measurement of quantity of fluids

## 2. Projects

Five projects have been proposed in 2017/2018. Four projects in terms of comparisons are ongoing and 12 are in progress. The EURAMET project 1379 - Comparison of primary standards for liquid micro flow rates has been concluded in 2017.

Two calibration guides were finished, namely (P1312 Guideline for Solid Anemometers – Part 1: Pitot static tubes and the third version of EURAMET-cg-19, v 3.0 guidelines on the determination of uncertainty in gravimetric volume calibration) which are for approval at the GA. One new guide (Guideline on the Calibration of Solid Anemometers - Part 2: Thermal Anemometers) is proposed. Furthermore a new guide on the Calibration, Operation and Handling of Micropipettes (E 1295 ) is under development.

## 3. Comparisons

The EURAMET TC-F members are very active within the BIPM key comparison (KC) level field. The sub committee convenors started to implement the new strategic tool for planning comparisons. One of the first results is that there is a need for new comparisons in the extended fields, by means of very high/low flow rate ranges or volumes. Furthermore, the service categories have been simplified by the WGFF.

The draft A for EURAMET.M.FF-K4.1.2016 Volume comparison at 20 L is for approval with the participants and the third draft A of the CIPM key comparison CCM.FF-K2.2011 Water and Hydrocarbon flow 5 - 60 kg/min has been sent to the participants.

#### 4. CMCs

During the 2018/2019 call for CMC revision all countries will revised their CMCs according to the new WGFF service categories. These will lead to a major reduction of CMC entries.

Two sets of CMCs were posted in the JCRB for RMO revision in 2017, EURAMET.M.2017.50 and EURAMET.M.2017.52. Both were already published in 2017. The new CMC revision process 2017/2018 started in December 2017 with the submission from 7 countries. The regional revision is almost at its end and in June the CMC will be sent for RMO revision.

Three CMC sets from other RMOs were reviewed in 2017 namely COOMET.M.27.2017, APMP.M.43.2017 and SIM.M.38.2017.

#### 5. Activities of the Subcommittees

The TC-F group is divided into four subcommittees (Gas flow, Liquid flow, Volume and Fluid speed) and 3 working groups (Strategy Working Group, CMC Review and comparisons Working Group, and EMPIR Task Force).

The subcommittee meetings are held separately during the TC-F meeting. Each subcommittee convenor decides on the agenda and the subjects to be debated based on participants' input. A poster session with the main calibration capabilities has been held during each subcommittee meeting. Furthermore, a World Café for each group has been initiated for gathering new ideas within the technical topics and therefore helps the participants to be very active.

- **Gas Flow subgroup** – Convenor – Bodo Mickan from PTB

The main topics of discussion were the information exchange and cooperation of NMIs/DIs regarding the traceability for measurements of flowing gas, meter testing technologies and the involvement in R&D activities in the gas metering market as well as standardization.

The subcommittee meeting also covered the following topics:

- Traceability of flow measurements to SI units
- Calibration services for the market
- Best practice for calibration and providing training for this
- Presentation of new technical developments:
  - increasing capacities for high pressure gas
  - inventing new technology for high pressure piston prover

- **Liquid Flow subgroup** – Convenor – Marc de Huu from METAS

In the liquid flow subcommittee meeting, the development and improvement of national standards and measuring methods in the field of liquid flow were discussed. Also the guide on harmonization of the uncertainty budgets and calibration methods for liquid flow standards was discussed to be started again in 2018.

The subcommittee meeting also covered the following topics:

- Methods to measure liquid flow
- Strategy for national and international liquid flow measurement infrastructure
- New research topics
- Dissemination of expertise and knowledge on liquid flow

- **Volume** – Convenor – Miroslava Benkova from CMI

In the volume subcommittee meetings the coordination and exchange of knowledge on developments in the field of volume measurements have been discussed. Furthermore, the active participation of ISO standards convenors supports the mutual work.

The subcommittee meeting also covered the following topics:

- Traceability of liquid volume measurement to SI units
- Discussion on key and supplementary comparisons results
- Elaboration of technical guides and technical statements
- Training activities in the field of volume measurements

- **Fluid speed** – Convenor – Pier Giorgio Spazzini from INRIM

The Fluid Speed Subcommittee meeting focussed on the methods for measurement of air speed and specifically on correction terms to be applied to measured values of airspeed; another important point was the approval of a Guide for the calibration of Pitot tube anemometers.

The Subcommittee meeting also covered the following topics:

- Status of an ongoing Comparison for the analysis of blockage effect;
- Comparison for very low air speeds;
- Feasibility of calibration of hydrometers in wind tunnels;
- Effects of inline pressure on Pitot tube measurements;
- Analysis of the Strategic Planning of Comparison, including identification of present needs for Comparisons in the field within EURAMET.

- **CMC Working Group** –Coordinator – Elsa Batista from IPQ

The working group has to coordinate the review of CMCs. A list about the status of comparisons will be updated every six months by the coordinator. Final reports of comparisons will be approved by the coordinator before publication at the EURAMET site.

One of the major tasks is to finally develop the comparison strategy plan which should be reviewed at least every four years.

- **Strategy Working Group** – Coordinator – Emmelyn Graham from NEL

The working group is meant to foster collaborations and research to ensure that the EURAMET TC-F continually meets its objective in a timely manner. It should provide information about the European Metrology Research system under consideration of different national needs and the differences among NMIs/DIs (size, organization, orientation). The aim is to create a map of the current landscape of coordination among EURAMET members and to bring it into alignment with the roadmap of the TC Flow. The following topics from the current roadmap have been discussed and developments identified:

- 1) Improved micro and nano flow measurements in health
  - Drug delivery & characterisation of biological flows
  - Development of new guidelines & regulations
  - Developments
    - EMPIR project on microflows & guideline documents & training produced
    - Applying for a new EMPIR project within TP Health in the frame of the EMPIR Call 2018

- 2) Improvement in measurement techniques for enhanced industrial efficiency
  - Development for cost-effective complex flow measurements
    - Covers multiphase flows, high temperature & pressure flows, higher viscosity, CO<sub>2</sub>, LNG flows.
  - Modelling & meter diagnostics
  - Developments
    - EMPIR project on multiphase including modelling, new ISO standard
    - EMRP / EMPIR LNG projects, new LNG facility soon, new ISO standards being developed
    - New elevated temperature & pressure facility, higher viscosity testing capability, CO<sub>2</sub> testing capability, R&D on meter diagnostics. Info feed into updated ISO standards.
- 3) Optimisation & reduction of energy consumption
  - Enhanced metering of energy-carrying fluids, e.g. hot water, LNG, biofuels, multiphase...
  - Networks, modelling and facilities for development of techniques
  - Developments
    - New facilities, advances in CFD modelling
    - Potential EMN on Energy Gases
    - EMPIR project on biofuels
- 4) Improvement of emissions & waste monitoring techniques
  - Traceable measurement techniques for emission/waste reduction, monitoring & trade
  - Updated regulations, policy, legislation & underpinning measurement techniques
  - IMPRESS I & II Stack emissions & landfill sites
  - Aligns with new EMPIR call in 2019 on Environment
- 5) Basic science for reduced uncertainty in traceability chains
  - New fundamental standard for absolute molecule counting
  - Change from traceability from SI length, mass & time to units of Ampere, Mol & Secs
  - Feasibility study under EMPIR?

An European Metrology Network (EMN) on flow metrology was supported by TC Flow members with the aim to increase coordination and actively seek alternative funding sources from EMPIR. The network would increase engagement with industry and academia to conduct underpinning research to bridge gaps in the current flow measurement standards and knowledge base to meet new flow metrology challenges. It has been decided to merge the proposed flow network with the EMN on Energy Gases.

- **EMPIR Working Group** – Coordinator – Corinna Kroner from PTB

One of the main goals of the working group is to facilitate the interaction between NMIs/DIs active in the area of flow measurements but also with stakeholders to prepare PRTs. A particular focus to significantly increase TC-F's activities within EMPIR by submitting a greater number and more competitive PRTs will therefore be set.

Possible flow related PRTs for the EMPIR call 2019 have been identified, such as:

- Determining new uncertainty requirements for increasingly stringent legislative HCl industrial emissions limits, and
- Metrology for outdoor air quality.

Ideas for the 2019 call have been gathered and will be distributed also to other TCs.

## 6. Participation in EMRP/ EMPIR

To foster the participation of TC-F members in EMPIR projects, the EMPIR working Group /Task Force has been implemented. Within the call 2018 the following PRTs and PNTs were submitted:

- Metrology for drug delivery II
- Metrology for blood solid particles clogging
- Metrology for assessing energy performance of buildings under actual conditions (Water flow/thermal energy and air flow (ventilation) will be concerned by this SRT)
- European metrology network for energy gases
- Flow metrology network

Flow-related EMPIR-projects active or about to start:

Number	Title	Coordination	Duration
15SIP03	Standards and e-learning course to maximise the uptake of infusion and calibration best practices	VSL	2016-2019
16ENG01	Metrology for hydrogen vehicles	NPL	2017-2020
16ENG07	Multiphase flow reference metrology	NEL	2017-2020
16ENG09	Metrological support for LNG and LBG as transport fuel	VSL	2017-2020
16ENV08	Metrology for air pollutant emissions	NPL	2017-2020
17IND13	Metrology for real-world domestic water metering	PTB	2018-2021

## 7. Capacity Building: Activities of the last year and future needs

During the World Cafe in 2017 the need for further workshops was realized. Therefore, the following workshops were/will be realized:

2017:

- Training on Uncertainty in Volume Measurements (BEV 28/29 Nov 2017)  
The training aimed at improving the knowledge of the laboratory staff in EURAMET NMIs/DIs on measurement uncertainty in static volume measurement.  
LOCATION: BEV, Vienna, Austria, 2017-11-28 to 2017-11-29  
Lecturers at the workshop: Elsa Batista (IPQ), Miroslava Benkova (CMI), Zoe Metaxiotou (EIM), Petra Milota (BEV), Wolfgang Schmid (EURAMET), Tanasko Tasić (EURAMET)

2018:

- Training on Calibration of Volume Equipment  
The training aimed at improving the knowledge of the laboratory staff in EURAMET NMIs/DIs on calibration of various type of volume equipment, by the gravimetric and volumetric method.  
LOCATION: IPQ, Caparica, Portugal, 2018-02-20 to 2018-02-23  
Lecturers at the workshop: Elsa Batista (IPQ)
- Workshop on preparation of CMC Excel files (TCF Meeting)  
The training aimed at improving the knowledge of NMIs/DIs regarding the rules and documents for submitting CMC files, new or revised entries.

- Workshop Uncertainty Calculation for Gas Meters (TCF Meeting)  
The workshop was focused on the establishment of comprehensive working equations and realistic estimation of uncertainties for the input values. A typical technical situation of a volumetric gas flow calibration facility was used as background.  
Lecturers at the workshop: Bodo Mickan (PTB)

2019:

- Training on Coordination of Comparisons
- Training on micro and nano flow calibrations
- Uncertainty components in gravimetric calibrations
- Workshop Uncertainty Calculation for Gas Meters: Part II
  - Procedures to estimate covariances among correlated input values.
  - Best practice for curve fits to represent calibration results.
  - Procedure to separate the contributions to Type A uncertainties between MuT and reference standard.

## 8. Meetings

The annual meeting of the TC-F was held in Funchal, Portugal, from 8<sup>th</sup> to 10<sup>st</sup> of May 2018. In the meeting several issues were discussed, mainly:

- Results from comparisons
- Development of calibration guides
- WGFF group and KCs
- EMPIR projects, proposals and funding
- Flow related EMNs
- Strategic planning tool for comparisons
- New roadmap
- Technical highlights (new developments, projects, new and unconventional facilities)
- Cooperation with other entities, ISO and OIML
- CMC review and simplification

The next TC-F meeting will be in Bern, Switzerland, from 9<sup>th</sup> to 11<sup>th</sup> April 2019 and hosted by METAS.

## 9. Strategic Planning

See strategy working group.

## 10. Outlook for 2018/2019

- Completion of the guidelines and development of new ones
- Review of all CMCs and implementation of the new service categories
- Foster the cooperation with standardization groups
- Review of Medical instrument directive to integrate MPEs for syringe pumps
- Finalising the strategic comparison plan

