1.General Aspects – Heading Arial 12 bold

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, such LNG (Liquified Natural Gas) or Hydrogen.

The first TC-F meeting was held in East Kilbride in 1988 with less than 10 participants.
The 33rd annual meeting was held online in May 2022. 76 members from 26 different countries attended this last TC-F meeting. It was organised online because of the not yet fixed sanitary conditions due to the COVID-19 pandemic.

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

The table below shows the status of the different projects listed for TC-F in the EURAMET Project database.

The numbers in brackets correspond to the change since the last report.

	Comparison	Research	Consultation	Total
Agreed	2 (+2)	0 (0)	0 (0)	2 (+2)
In progress	8 (-6)	2 (0)	1 (+1)	11 (-5)
Ongoing	0 (0)	2 (0)	0 (0)	2 (0)
Completed	78 (+6)	11 (+1)	7 (0)	96 (+7)
Concluded	6 (+1)	1 (0)	0 (0)	7 (+1)
Total	**94 (+3)**	**16 (+1)**	**8 (+1)**	**118 (+5)**

3. Comparisons

The EURAMET TC-F members are very active within the BIPM key comparison (KC) level field.

The status of the different comparisons in which the TC-F is involved is given in the table below (changes since the last annual report are marked in red in the status column). Only comparisons agreed, in progress or approved and completed or concluded within the year are listed.

EURAMET n°	Title	Coordinating Institute	Status	KCDB
-	Water flow: 30 m^3/h to 200 m^3/h	PTB	Approved for equivalence	CCM.FF-K1.2015
-	Hydrocarbon liquid flow and water flow from 10 kg/min to 60 kg/min	VSL	report in progress, Draft B	CCM.FF-K2.2011
-	High pressure gas flow from 65 m^3/h to 1450 m^3/h (0,1 to 8,8 MPa)	PTB	Measurements in progress	CCM.FF-K5.2021
-	Low pressure gas flow from 2 cm^3/min to 10000 cm^3/min	CMS/ITRI	Approved for equivalence	CCM.FF-K6.2017
1224	Comparison VSL - PTB Volume flow for Natural Gas under High Pressure	PTB	concluded	
1397	Comparison of high-pressure gas-flow facilities between NEL, PTB and FORCE	NEL	in progress	
1450	Comparison of low air speed	CMI	completed	EURAMET.M.FF-S11
1473	PTB-VTT MIKES DN100 comparison	MIKES	completed	EURAMET.M.FF-S13
1476	Air flow low pressure Qmax 400 m3/h	VSL	in progress	EURAMET.M.FF-S12

EURAMET n°	Title	Coordinating Institute	Status	KCDB
1479	Inter-comparison of 1000 L proving tank	MIRS	completed	EURAMET.M.FF-S14
1504	Bilateral inter-comparison in the gas flow range from 0.002 m3/h to 2.5 m3/h with sonic nozzles	CMI	in progress	
1506	Validation of standards for liquid flow rate under dynamic flows	LNE-CETIAT	completed	
1507	Comparisons of standards for liquid flow rates under static load changes	CMI	in progress	EURAMET.M.FF-S17
1515	Comparison of air speed in the range of 1-40 m/s	UME	completed	
1517	Pilot study on high-pressure natural gas primary calibration facilities	VSL	in progress	
1518	Inter-comparison of gas provers in the gas flow range 0,25 m3/h to 25 m3/h	BEV	in progress	
1526	Supplementary comparison of gravimetric standards for hydrogen refuelling stations	LNE-LADG	in progress	EURAMET.M.FF-S15
1533	Comparison of piston-operated volumetric instruments	DMDM	in progress	EURAMET.M.FF-S16

EURAMET n°	Title	Coordinating Institute	Status	KCDB
1553	Supplementary comparison liquid volume – 500 mL and 5000 mL volumetric glass flasks	VSL	In progress	EURAMET.M.FF-S19
1571	Supplementary bilateral comparison for small gas flow rates (2 to 1000) SCCM at STP with Laminar Flow Elements	METAS	In progress	EURAMET.M.FF-S18

4. CMCs

The following CMCs have been submitted for JCRB review in 2022 via the KCDB 2.0 web platform. The date of approval is also given in the Table.

NMI	Country	Field	Number of CMCs	Date of Approval(*)
BEV	Austria	Gas Flow	3	
DMDM	Serbia	Gas flow	1	
SMU	Slovakia	Gas flow	f	2022-08-11
BEV	Austria	Liquid flow	4	
MIKES	Finland	Liquid flow	1	2022-08-11
LNE-CETIAT	France	Liquid flow	1	2022-08-05
IPQ	Portugal	Liquid Flow	2	2022-07-09
RISE	Sweden	Liquid flow	1	2022-08-11
METAS	Switzerland	Liquid flow	1	2022-09-01
BEV	Austria	Volume	6	

The following CMCs from other RMOs were reviewed in 2022:

NMI	Country	Field	Number of CMCs	Date of Approval (*)
NIM	China	Volume	1	
KRISS	Korea	Volume	2	
LPEE-LNM	Morocco	Volume	1	2022-02-02

(*): for new CMCs only

It is worth noting:

- The number of new CMCs within EURAMET resulting in particular from the development of new calibration facilities in a new liquid flow range in the framework of an EMPIR project (for the different countries participating in this project), 18HLT080
- The higher activity than the other RMOs (number of new or modified CMCs)

5. Activities of the Subcommittees

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

The subcommittee meetings are held separately during the TC-F annual meeting. Each subcommittee convenor decides on the agenda and the subjects to be debated based on participants' input.

The following topics were discussed during the subcommittee meetings:

- Gas Flow subgroup: Toma Valenta (CMI)
  - Status of the on-going projects
  - Presentation of a new equipment (Bell Piston prover type) by CMI
- Liquid Flow subgroup: Florestan Ogheard (LNE-CETIAT)
  - Status of the on-going projects
  - Presentation of the liquid flow facilities at LNEC Portugal by Álvaro Ribeiro
  - Presentation of the INRIM Dynamic gravimetric liquid flow standard by Andrea Malengo
- Volume subgroup : Elsa Batista (IPQ)
  - Status of the on-going projects
  - Active participation of ISO standards' convenors with presentations
- Flow speed subgroup : Jan Gersl (CMI)
  - Status of the on-going projects
  - Proposal of a new research project related to the insertion depth effect of anemometers (CMI)
  - Presentation of a new facility for the calibration of anemometers by Robert Walsh, NSAI (Ireland)

The Working Group coordinators and activities are:

- CMC working group: Isabelle Caré (LNE-CETIAT)
  - The review team (12 members with an expertise in the different fields) is in charge of the CMCs review (see §4)

- Strategy working group: Chris Mills (NEL)
  - 7 members
  - Decision to upgrade the strategy roadmap in 2022

- Research Programme working group: Corina Kroner (PTB)

6. Participation in EMRP/ EMPIR

Information on the participation of TC Flow members in on-going EMPIR projects:

Number	Short name	Full name	Coordination	Duration
18HLT08	MeDDII	Metrology for drug delivery	IPQ	2019-2022
18NRM06	NEWGASMET	Flow metering of renewable gases	LNE	2019-2022
18NET01	Energy Gases	Support for a European Metrology Network for energy gases	VSL	2019-2023
19ENG04	MetroHyVe 2	Metrology for hydrogen vehicles 2	NPL	2020-2023
19ENV09	MetroPEMS	Improved vehicle exhaust quantification by portable emission measurement systems metrology	PTB	2020-2023
20NRM02	MFMET	Establishing metrology standards in microfluidics devices	IPQ	2021-2024
20IND10	Decarb	Metrology for decarbonizing the gas grid	NPL	2021-2024
20IND11	MetHyInfra	Metrology infrastructurefor high-pressure gas and liquid hydrogen flows	PTB	2021-2024
20IND13	SAFEST	Sustainable advanced flow meter calibration for the transport sector	PTB	2021-2024
21ENV06	CCUS	Metrology support for carbon capture utilization and storage	NPL	2022-2025

Number	Short name	Full name	Coordination	Duration
21ENV05	MET4H2	Metrology for the hydrogen supply chain	VSL	2022-2025

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

Different activities of training and workshops in the field of fluid flow realized in the last years are listed above, as well as future needs already identified:

- 2017
  - Training on Calibration of Volume Equipment
    - Objective: Improvement of 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
    - Lecturer(s): Elsa Batista (IPQ), Miroslava Benkova (CMI), Zoe Metaxiotou (EIM), Petra Milota (BEV), Wolfgang Schmid (EURAMET), Tanasko Tasić (EURAMET)
- 2018
  - Training on Uncertainty in Volume Measurements
    - Objective: Improvement of 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
    - Lecturer(s): Elsa Batista (IPQ)
  - Workshop on preparation of CMC Excel files
    - Objective: Improvement of the knowledge of NMIs/Dis regarding the rules and documents for submitting CMC files, new or revised entries
    - Location: 2018TC-F meeting
    - Lecturer(s): Elsa Batista (IPQ)
  - Workshop Uncertainty Calculation for Gas Meters
    - Objective: 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 use as background
    - Location: 2018 TC-F meeting
    - Lecturer(s): Bodo Mickan (PTB)

- 2019
  - Training on Coordination of Comparisons
    - Objective: Improvement of the knowledge of the TC-F members about the coordination of comparisons
    - Location: 2019 TC-F meeting
    - Lecturer(s): Elsa Batista (IPQ)
  - Training on micro and nano flow calibrations
    - Objective: Improvement of the knowledge about micro and nano liquid flow
    - Location: 2019 TC-F meeting
    - Lecturer(s): Hugo Bissig (METAS)
  - Workshop Uncertainty Calculation for Gas Meters: Part II

        - Objective: 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
        - Location: 2019 TC-F meeting
        - Lecturer(s): Bodo Mickan (PTB)
- 2021[1]
    - Uncertainty components in gravimetric calibrations in liquid flow
        - Objective: Improvement of the knowledge of the TC-F members
        - Location: 2021 TC-F meeting
        - Lecturer(s): Florestan Ogheard (LNE-CETIAT)
    - Workshop Calibration on Micropipettes and standardization
        - Objective: Improvement of the knowledge of the TC-F members
        - Location: 2021 TC-F meeting
        - Lecturer(s): Zoe Metaxiotou (EIM)
    - EURAMET-COOMET training course on small volume comparisons
        - Objective: Improvement of the knowledge of the laboratory staff in EURAMET and COOMET NMI/DIs on measurement uncertainty evaluation of interlaboratory comparisons in small static volume measurement
        - Location: 2021-10-18&19 online
        - Lecturer(s): Elsa Batista (IPQ), Zoe Metaxiotou (EIM)
    - In house verification of piston pipettes
        - Objective: To provide hospital laboratories with a brief, handy “Rescue Manual ” for performing a quick in house verification of the measuring status of pipettes in order to identify the ones which do not perform safely within specifications in the context of Covid-19 crisis
        - Location: Euramet website
        - Lecturer(s): Elsa Batista (IPQ), Zoe Metaxiotou (EIM)
- 2023
    - Organization of a TC Flow Summer School planned

8. Meetings

Due to the not yet fixed sanitary situation and the possible limitation for travelling decided by the different countries and NMIs, the TC-F meeting, initially planned in Ljubljana, Slovenia, was organized online in May 2022. (After a poll organized in January 2022 to evaluate the intention of travel).
rescheduled online 31 August – 01 September 2021.
The Volume Subcommittee’s convenor (Elsa Batista, IPQ) has organized an online meeting in January 2022 to discuss about the projects (in progress and planned) and the need to revise the guides.

9. Issues

No particular issue has been reported.

[1] 2020 activities have been postponed in 2021 due to the pandemic situation

10. Strategic Planning

See strategy working group.

11. Outlook for 2023/2024

- Review of CMCs
- Foster the cooperation with standardization and regulation groups
- Develop a new strategy plan
- Organization of a TC Flow Summer School