

## 1. General Aspects

Previous reporting and meeting.

In the previous reporting period TC-M had neither meeting because of the COVID situation nor Annual Report.

Change of the TC-Chair.

In 2021 a new TC-Chair Zoltán Zelenka (BEV, AT) was elected (29/06/2021). He is supported by the previous Chair Fredrik Arrhén (RISE, Sweden).

Current work:

In the current reporting period TC-M had only online meetings.

The Strategy Working Group have monthly meetings.

## 2. Projects

TC-M had 23 active projects in the reporting period. 20 comparisons and 3 research ones. 5 projects were finished and 3 new ones started.

Table 1. Status of the projects (in progress) at the beginning of the period.

Nr	Start	proposed Completion	Title and type of the project.	NMI	Development, notes
505	01.01.2013	2022	<a href="#">Comparison of force standards from 500 kN to 4 MN</a> <a href="#">EURAMET.M.F-K3</a>	PTB	Draft B report in progress.
890	01.08.2006	2021	<a href="#">Dynamic Force Measurement Research</a>	PTB	Completed
4445	01.08.2010	2020-01-15	<a href="#">R-134a leak comparison in atmospheric pressure</a>	LNE	Completed: <a href="#">Final Report</a> 2022-02-03
4206	02.11.2011	2021-12-31	<a href="#">Bilateral comparison in the barometric absolute pressure range 800 to 1100 hPa</a>	MIKES	Completed: <a href="#">Final Report</a> 2022-10-21
1207	02.11.2011	2021-12-31	<a href="#">Bilateral comparison to determine the effective area of the piston cylinder unit by cross-floating</a>	MIKES	Progress report 2021-05-05
1262	01.12.2012	30.03.2022	<a href="#">Determination of Forces (tension and compression) from 5 N up to 250 kN with two new Dead Weight Machines developed and realised by BEV</a> <a href="#">EURAMET.M.F-S2</a>	BEV	Progress Report 2021-03-16, Draft B accepted by the participants
4300	01.01.2014	2021-09-01	<a href="#">Comparison of 500 kg stainless steel standard</a> <a href="#">EURAMET.M.M-S7</a>	MIRS	<a href="#">Final report</a> 2021-07-31
1304	15.09.2014	2021-03-31	<a href="#">Comparison of torque standards from 0.1 N·m at 50 N·m</a> <a href="#">EURAMET.M.T-S4</a>	LNE	Staff changes in LNE, TC-M contacted LNE

Nr	Start	proposed Completion	Title and type of the project.	NMI	Development, notes
1375	01.09.2015	2021-04-16	<a href="#">Bilateral comparison in high gauge pressure 250 MPa</a>	GUM	Progress Report 2021-05-06 Draft B finished, under approval now.
1411	01.09.2016	2021-12-31	<a href="#">Dynamic high-pressure comparison</a>	MIKES	Progress Report 2021-05-05 Draft A
1416	15.03.2017	2017-05-15	<a href="#">Bilateral study comparison in the high vacuum range from 5E-7 Pa to 9E-4 Pa.</a>	CMI	Progress Report 2022-04-05
1428	01.09.2018	2020-07-01	<a href="#">Comparison of torque standards from 100 N.m to 5000 N.m EURAMET.M.T-S5</a>	LNE	Staff changes in LNE, TC-M contacted LNE
1440	01.04.2018	2020-11-01	<a href="#">KC Density of liquids CCM.D-K5</a>	BEV	Progress Report 2021-10-26, Circulation start in 2022-05.
4444	01.06.2017	2022-04-01	<a href="#">Calibration guides for force and torque traceability</a> Research	NPL	Final Report 2022-03-17 Force and torque split, force finished, torque will start this year.
1494	01.09.2019	2022-12-31	<a href="#">Key Comparison of National Pressure Standards in the Range 1 Pa to 15 kPa of Absolute and Gauge Pressure EURAMET.M.P-K4.2020</a>	PTB	KC covid-delayed. All Measurements finished.
4496	02.03.2020	2021-02-25	<a href="#">Calibration of high resolution hydrometers EURAMET.M.D-K4.2020</a>	INRIM	Final Report 2022-01-31
1522	01.02.2021	2021-09-30	<a href="#">Key comparison on density determination of liquids by hydrostatic weighing EURAMET.M.D-K2.1</a>	BEV	Progress Report 2021-10-27 Draft A in preparation
1523	01.02.2021	2021-09-30	<a href="#">Key comparison on density determination of liquids using oscillation type density meters EURAMET.M.D-K2.2</a>	BEV	Progress Report 2021-10-27 Draft A in preparation
1529	01.04.2021	2021-10-31	<a href="#">Comparison of torque standards from 10 N.m to 500 N.m EURAMET.M.T-S6</a>	PTB	Staff changes in LNE, TC-M contacted LNE
1532	02.11.2020	2022-04-30	<a href="#">Comparison of stainless steel multiples and sub-multiples of the kilogram</a>	UME	Project was extended with new participants.
<b>New projects</b>					
1536	21.09.2021		<a href="#">Finalisation of the draft Calibration Guideline on the Calibration of Automatic Catchweighing Instruments</a> Research	MIRS	
1549	21.03.2022		<a href="#">Bilateral supplementary comparison in gas media (absolute mode) in the range from 10 kPa to 200 kPa</a>	MIRS	
1550			<a href="#">Bilateral supplementary comparison in gas media (gauge mode) in the range from 0.1 MPa to 3.5 MPa</a>	MIRS	
-	12.05.2022		Supplementary comparison of 20 kg mass standards. Registration in progress.	BEV	New agreed project for EURAMET participants in the COOMET.M.M-S3.

### 3. Comparisons

See table above. Projects not marked as “research” are comparison projects.

### 4. CMCs

New reviewer: Density – [Daniela Eppers](#), PTB

In 2021-2022 54 CMCs were in progress and most of them published.

Altogether TC-M has about 1300 CMCs.

One institute greyed out some of its CMCs and another one is working on reinstating.

### 5. Activities of the Subcommittees

A new Subcommittee on Gravimetry was initiated, supported by the BoD and probably will be approved by the General Assembly in June 2022.

A group on digitalisation has been established.

A communication group has been established.

#### SC-Mass

Project 1300, a comparison of 500 kg stainless steel standard (EURAMET.M.M-S7) had been completed and published in the KCDB. Issues had been discovered during the comparison regarding the magnetic permeability of the weight which only met OIML Class F1 specifications. However, the results of the comparison are adequate to support the majority of published (and proposed) CMCs from the participants.

Project 1532, a comparison of multiples and sub-multiples of the kilogram (EURAMET.M.M-K7) was underway and is due for completion this year.

Project 1536 to produce a Calibration Guideline on the Calibration of Automatic Catch-weighing Instruments is underway.

An EMPIR project, 19RPT02 RealMass (aims to improve the realisation and dissemination of the mass scale) is progressing well. Software is being developed to implement the methods devised and the results will be validated by means of an intercomparison between the project participants. The project will be completed next year.

Cooperation with COOMET is ongoing and in particular, several EURAMET TC-M members are participating in a COOMET piloted 20 kg comparison.

At the Sub-committee meeting in October 2021 details of the implementation of the kilogram redefinition, adjustment of CMCs and the comparison of realisation experiments were presented.

## **SC-Pressure**

Project 1115, an R-134a leak comparison in atmospheric pressure, has been completed. It is not registered in the KCDB. It was the first time that NMIs performed a comparison of small leak flow rates around  $4 \cdot 10^{-10}$  mol/s flowing to the atmosphere. Three NMIs presenting results, CMI, LNE and PTB, used three different primary methods and demonstrated good equivalence with the reference value.

Project 1206, a bilateral comparison in the barometric absolute pressure range of 800 to 1100 hPa, between MIKES and MCCA, was finished few years ago and showed good agreement between the two NMIs.

Project 1207, a bilateral comparison to determine the effective area of the piston cylinder unit by cross-floating, between MIKES and MCCA, has been finished. Draft B report is in progress.

Project 1375, a bilateral comparison in high gauge pressure up to 250 MPa, between GUM and CMI, has been finished. Draft B report has been submitted to CCM WG PV for approval.

Project 1411, a pilot study: Dynamic high pressure comparison, between MIKES and KRISS, is in progress.

Project 1494, a key comparison of national pressure standards in the range 1 Pa to 15 kPa of absolute and gauge pressure, required a travel of NMIs staff with their standards to CMI, the linking lab, and due to the COVID pandemic has been delayed. The last measurements could be finished in April 2022, and the KC is expected to be finished in 2022.

Two new projects, 1549 and 1550, bilateral supplementary comparisons in gas media (absolute mode) in the range from 10 kPa to 200 kPa and (gauge mode) in the range from 0.1 MPa to 3.5 MPa, between MIRS and IMT, started in 2022.

EMPIR project 18SIB04 QuantumPascal, Towards quantum-based realisations of the pascal, started 2019 and is in progress. This project deals with developing photon-based standards which determine the pressure via gas density using the gas law. A follower project entitled "Metrology for quantum-based traceability of the pascal" has been submitted within EPM call-2022 and selected.

## **SC-Density and viscosity**

Project 1440 is a key comparison of density determination of liquid samples using oscillation-type density meters (CCM.D-K5) piloted by BEV (Austria) and supported by BFKH (Hungary). Initially planned for 2019. Several circumstances led to postponing the beginning of the measurement phase to May 2022. EURAMET 1440 KC will start at exactly the same time and with the same liquids as in the CCM.D-K5, therefore the link between them it is not necessary, meaning that the reference values must only be determined once (BEV will produce the reference value for the EURAMET.M.D-K2 and PTB the reference value for the CCM.D.-K2). This comparison was organized to link EURAMET comparisons in this area. Progress report on 2021-10-26.

Project 1496 is a key comparison on calibration of high-resolution hydrometers (EURAMET.M.D-K4.2020), piloted by INRIM (Italy) and co-piloted by PTB (Germany). The measurements were carried out between March 2020 and February 2021. The first Draft A was sent for comments in July 2021 and Draft B was sent accepted in October 2021. The final report was issued on 2022-01-31. The comparison has been completed and the results are available in the KCDB. In this key comparison no reference value was determined; instead the degrees of equivalence was calculated to the KCRV of the CIPM Key comparison CCM.D-K4, in which similar hydrometers

were used. The link correction was evaluated by the mean values of two linking laboratories, INRIM and PTB. The results were presented (in general the results have been positive and supported the CMCs, with only 15 % discrepant results).

Project 1522 is a key comparison on density determination of liquids by hydrostatic weighing (EURAMET.M.D-K2.1) and Project 1523 is a key comparison on density determination of liquids by using oscillation type density meters (EURAMET.M.D-K2.2), both piloted by BEV (Austria), and organized within the framework of the EMPIR 17RPT02 rhoLiq project. The measurement phase was finalized on the 24th of November 2021. Draft A was prepared on 2022-05-09. Progress report was prepared on 2021-10-27.

#### Outlook for 2022/2023:

Under the scope of rhoLiq Project 3 draft guides were produced on the topic of liquids density, with the intention of being revised and accepted as EURAMET Guidelines:

- No. x | Liquid's density measurements by hydrostatic weighing method
- No. x | Liquid's density measurements with oscillation-type density meters
- No. x | Production and use of adequate liquid density (certified) reference materials

GUM (Poland) presented the intention to register a EURAMET pilot study on "Surface tension of liquids". This project counts already with the intention of participation of 3 participants: 2 confirmed (IPQ/Portugal, and INMETRO/Brazil); and PTB/ Germany. This project intended to start in the first trimester of 2022, and Final report is planned to be concluded during the Summer/Autumn 2023.

### SC-Force

In project 1441 the work on the "Guidelines on the Uncertainty of Force Measurements" (Calibration Guide No. 4) was completed in October 2021 and approved at the TC-M meeting. After some minor modifications, it was then further approved by the EURAMET Board of Directors in February 2022 and published on the EURAMET website on 3 March 2022:

file:///C:/Users/Kumme01/Downloads/I-CAL-GUI-004\_Calibration\_Guideline\_No.\_4\_web.pdf

It was subsequently decided to close this project and to address the development of a torque traceability guide within a separate project to be defined next TCM SC-Force meeting.

Two EMPIR projects are currently running, which are related to Force and Torque.

In project 18SIB08 ComTraForce advanced models and procedures for the traceability of force measurement for continuous and dynamic forces in particular in respect to material testing machines are investigated and developed.

Project website: <https://www.ptb.de/empir2019/comtraforce/home/>

In the project 19ENG08 WinEFCY EMPIR traceable methods for the efficiency determination of wind turbines are developed and investigated. In this interdisciplinary project the mechanical power measurement is investigated traceable to the torque and rotational speed measurement. The electrical power measurement is traceable to voltage and current measurement to improve the efficiency determination of wind turbines on test benches.

Project website: <https://www.ptb.de/empir2020/windefcy/home/>

Project 505 was already proposed in 2000 but the measurements for the 0.5 MN and 1 MN EUAMET Key Comparisons were performed from 2013 to 2021. 13 NMIs participated in this star type comparison. The measurements were completed in 2021 and the report (Draft B) is in progress.

### **Proposed SC-Gravimetry**

After the TC-M annual meeting in 2021, according to the recommendation of our TC, the Subcommittee on Gravimetry was proposed to EURAMET. It was widely discussed, a Convenor was proposed, and an initial membership has been gathered from the known experts.

As the next step, the Board of Directors supported it at their meetings (9 March 2022). Now we are waiting for the gathering of the General Assembly to approve the subcommittee (May 2022). Hopefully, it will be accepted, and if so, the first meeting of the SC Gravity will be at our annual meeting in Borås.

Having introduced gravimetry SC in the TC-M, it was also proposed to add the area to IMEKO [TC-3 topics](#).

## **6. Participation in EMRP/ EMPIR**

The following projects had activities in the reporting period:

- **The EMPIR project 17RPT02** “Establishing traceability for liquid density measurements (RhoLiq)” started in May 2018 and finished in April 2022. The project was extended due to the pandemic.
- **The EMPIR project 17IND07** “Development of measurement and calibration techniques for dynamic pressures and temperatures” is completed.
- **The EMPIR project 18SIB04** “Towards quantum-based realisations of the pascal” is in progress. The project was delayed due to the pandemic.
- **The EMPIR project 18SIB08** “Comprehensive traceability for force metrology services” is in progress. The project was delayed due to the pandemic.
- **The EMPIR project 19ENG08** “Traceable mechanical and electrical power measurement for efficiency determination of wind turbines” is in progress. The project was delayed due to the pandemic.
- **The EMPIR project 19RPT02** “Improvement of the realisation of the mass scale” is in progress. The project was delayed due to the pandemic.
- **The EMPIR project 20SIP01** “Developing an ISO Technical Specification ‘Characteristics for a stable ionisation vacuum gauge’” is in progress.

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

The future needs were collected in 2021 and in the training activities are in planning phase now. Some workshops are already in progress (like on dynamic measurements, which will be in conjunction with the TC-M Annual Meeting). The TC-M Working Group on Strategy together with the EURAMET capacity building officer are developing general and focussed training packages in the areas of mass and pressure which are likely to be held at NPL and RISE respectively. The aim is that these will take place from late autumn 2022 to spring 2023.

## **8. Meetings**

The Subcommittee and working group meetings were organised a week before the Annual Meeting:

1. WG Strategy – Closed meeting
2. Force - Meeting on project 1441
3. SC Force
4. SC Pressure
5. Gravity meeting (it is not an official subcommittee yet)
6. SC Mass
7. SC Density and viscosity

The TC-M annual meeting was held online. The one-day meeting was very intensive. The agenda is on the next page.

**Time** Wednesday 27<sup>th</sup> October 2021 9h00 to 16h15 CEST  
**Place** Online via MS Teams Meeting  
**Responsibility** TC-M Chair, Zoltan Zelenka (BEV, AT)  
**Participants** Contact Persons  
 Subcommittee contacts, Invitees

Time	Ref	Item	Document	By
8:50	0	Opening the room		EURAMET
9h00	1	Opening of the meeting		TC-Chair
	1.1	Welcome to the participants		
	1.2	Adoption of the agenda		
9h10	2	EURAMET Information		
	2.1	EURAMET Strategy and more, Jörn Stenger		EURAMET Chair
	2.2	EURAMET new, inclusive Capacity Building, Tanasko Tasić		Capacity Building Officer
10h45		Short Break		
11h00	3	BIPM information		
	3.1	CCM news and BIPM technical work, Hao Fang		CCM Secretary
	3.2	Exchange and progress with KCDB 2.0, Susanne Picard		KCDB Coordinator
11h45	4	TC-M reports		
		Adoption of the previous minutes		TC-Chair
		WG-Strategy, Stuart Davidson		WG Coordinator
		SC Density and Viscosity, Andreia Furtado		SC Convenor
		SC Force, Rolf Kumme		SC Convenor
		SC Pressure, Wladimir Sabuga		SC Convenor
		SC Mass; Stuart Davidson		SC Convenor
		Gravity, Alessandro Germak		-
12h45		Lunch Break		
13h45	5	Digital Transformation		
		Digital transformation and Digital Calibration Certificates, Anke Keidel		Chair of 1448
		Discussion DCC and the task of our TC in the progress		All
14h15	6	Project reports		
		Any project that has interest to broader public (no SC specific ones)		Chair of 1448
14h30	7	Collaboration, communication		
		News from COOMET, Iryna Kolozinskaya		COOMET TC-Chair
		Cooperation with EMNs, Advanced Manufacturing (How TC-M can help them); Harald Bosse		EMN Coordinator
		Communication, collaboration within our TC		TC-Chair
15h00		Other Business, next meeting		
15h15		End of the meeting or Short Break		
		Reserved for any delay		
16h15		End of the meeting		

**Notes:** Documents may be submitted later.

## 9. Issues

None, except for the missing in-person meetings.

## 10. Strategic Planning

The calibration guides have been revisited. The list of the guides to be updated is under the section outlook for 2022/2023.

The TC-M will improve sharing information via SharePoint and newsletters.

The organisation of the trainings, generally capacity building is planned to be improved.

TC-M has collected the interested experts in Digitalisation within our TC. According to the decision that will be made at our next annual meeting, this group can be transformed into an official working group.

Working with COOMET and eventually with other RMO is favourable. (This work is affected by the current situation in Ukraine.)

Our TC as [CCM](#) too is cooperating with [IMEKO TC3](#) mainly by using the [publication possibilities](#) and [conferences](#) provided by [IMEKO](#).

TC-M shall develop a policy on handling the guides, provided by different projects, that cannot be classified as calibration guides.

An example is: the EMPIR project DynPT (Development of measurement and calibration techniques for dynamic pressures and temperatures). "Further work will be needed within TC-M ... The current draft guide is rather a summary of main findings and recommendations based on project outcomes."

## 11. Outlook for 2022/2023

The TC-M 2022 meeting will be held in Boras in September.

The Working Group on Strategy will maintain its monthly meetings to improve the quality of the work in our TC.

The KTCB activities are under planning and several activities will be carried out during coming the period.

TC-M is planning update the following guides:

- No. 3 | Calibration of Pressure Balances | TC-M | Version 1.0, 03/2011
- No. 14 | Guidelines on the Calibration of Static Torque Measuring Devices | TC-M | Version 2.0, 03/2011
- No. 16 | Guidelines on the Estimation of Uncertainty in Hardness Measurements | TC-M | Version 2.0, 03/2011
- Under the scope of rhoLiq Project, three draft guides are to be revised and accepted as EURAMET Guidelines. (See more [details](#))

