

20 May 2009

1. General Aspects

The Contact Persons meeting was held in Malta at the beginning of March and was again very successful with over 70 participants from 31 countries. There is a trend towards increased participation from smaller NMIs particularly in the South Eastern European area. A number of collaborations are also being organised in this region to involve comparisons and knowledge transfer activities. Several areas of collaborative research are being explored including dynamic measurement, kilogram mise-en-pratique, FEA modelling for pressure balances and micro- and nano- mass and force measurements. Fifteen new projects have been registered this year and have included comparisons and co-operations in a wide spread of technical areas. Notably two projects have been registered in the area of gravimetry for the first time.

Stuart Davidson's period as TC-M comes to an end this summer and three potential replacements were identified. All three were excellent candidates and the next TC-M Chairman, as elected at the EURAMET Board of Directors meeting, will be Walter Bich from INRiM, Italy.

2. Projects

In the period under review (June 2008 – May 2009) in TC area of Mass and Related Quantities the numbers of proposed, agreed and completed projects in the various categories are shown in the table below. The previous years numbers are shown in brackets.

	Comparison	Co-operation	Traceability	Consultation	Total
Proposed	14 (9)	6 (5)	-	-	20 (13)
Agreed	18 (15)	12 (11)	3 (3)	1 (1)	34 (30)
Completed	32 (27)	29 (27)	6 (6)	11 (11)	78 (71)
Total	64 (51)	47 (43)	9 (9)	12 (12)	129 (114)

The projects can be broken down by technical area as follows:

	Proposed	Agreed	Completed	Total
Density	1	3	5	9
Force	4	6	4	14
Hardness			1	1
Mass	5	15	31	51
Pressure	9	11	29	49
Torque	1		1	2
Viscosity		1	4	5
Gravimetry			2	2

General trends are that new research projects have been started in the mass area. In the technical area of pressure new projects have tended to be comparisons. Comparisons have also been registered in the areas of gravimetry and torque.

Comparisons have also been undertaken under the auspices of PHARE (Pologne, Hongrie Assistance à la Reconstruction Economique) and SEE (Building an Appropriate Metrology Infrastructure in South Eastern European Countries) and have been registered as EURAMET projects (the latter also as TC-IM projects, since they were the outcome of a TC-IM Focus Group). The comparisons cover the technical areas of Force, Mass and Pressure.

3. Comparisons

There are currently 25 registered European Regional Key Comparison in the area of Mass and Related Quantities, of which 11 are active, 4 have provisional equivalence, 10 have been approved for equivalence. Details are given in the table below.

Comparison ID	Project no.	Title	Pilot	Status	Years
EUROMET.M.M-K1	215 C	Kilogram	NPL	Approved for equivalence	1992-1999
EUROMET.M.M-K2	445 A	(Sub-)multiples	SP	Report in progress, Draft B	2001-2003
EUROMET.M.M-K2.1	786 A	(Sub-)multiples	SP	In progress	2004-
EUROMET.M.M-K4	510 A	Kilogram	NPL	Approved for equivalence	1999-2003
EUROMET.M.M-K4.1	510 A	Kilogram	MIRS	Approved for equivalence	2007-2008
EUROMET.M.D-K1	339 C	Solid (3 ceramic spheres)	METAS	Provisional equivalence	1998-1999
EUROMET.M.D-K1	1031 C	Solid (3 silicon spheres)	PTB	In progress	2008-2010
EUROMET.M.D-K2	627 A	Liquid density	PTB	Report in progress, Draft B	2001-2002
EUROMET.M.D-K4.Prev	236 C	Hydrometers	IMGC	Approved for equivalence	
EUROMET.M.D-K4	702 A	Hydrometers	IMGC	Report in progress, Draft B	2003-2006
EUROMET.M.P-K1.a	442 A	0.1 Pa to 1000 Pa	BNM-LNE	Approved for equivalence	1999-2002
EUROMET.M.P-K1.b	442 A	0.3 mPa to 9 Pa	BNM-LNE	Approved for equivalence	2000-2002
EUROMET.M.P-K1.b.1	1070 C	0.3 mPa to 9 Pa	PTB	Proposed	
EUROMET.M.P-K2	305 C	1 MPa to 4 MPa	PTB	Approved for equivalence	1994-1995
EUROMET.M.P-K3.a	439 A	0.05 MPa to 1 MPa	LNE/NPL	Approved for equivalence	1999-2001
EUROMET.M.P-K3.b	439 A	0.05 MPa to 1 MPa	NPL	Report in progress, Draft B	1999-2001
EUROMET.M.P-K4	389 C	10 MPa to 100 MPa	NPL	Approved for equivalence	1998-1999
EUROMET.M.P-K5	045 C	50 MPa to 500 MPa	BNM-LNE	Provisional equivalence	1993-1995
EUROMET.M.P-K6	110 C	100 MPa to 1000 MPa	BNM-LNE	Provisional equivalence	1992-1994
EUROMET.M.P-K7	881	50 MPa to 500 MPa	MIKES	Provisional equivalence	1992-1994
EUROMET.M.F-K1	535 A	5 kN to 10 kN	MIKES	Report in progress, Draft A	2002-2004

EUROMET.M.F-K2	518 A	50 kN to 100 kN	NPL	Proposed	2007-2008
EUROMET.M.F-K3	505 A	500 kN to 4 MN	PTB	Proposed	2005-2007
SIM-EUROMET.M.P-BK3		3 mPa to 0.9 Pa	PTB/CENAM	Approved for equivalence	2001-2002
SIM-EUROMET.M.P-BK4		10 MPa to 100 MPa	PTB/CENAM	Approved and published	2002

There are also 14 supplementary comparisons, four of which have been carried out over the last year. Of the 14 comparisons 11 have been published and three are awaiting the publication of the final report.

Comparison ID	Project no.	Details	Pilot	Status	Years
EUROMET.M.V-S1	273 C	Viscosity	PTB	Published	1992-1993
EUROMET.M.V-S2	303 C	Viscosity	PTB	Published	1993-1996
EUROMET.M.V-S3	415 C	Viscosity	PTB	Published	2000
EUROMET.M.V-S4	415 C	Viscosity	PTB	Published	1997
EUROMET.M.M-S1	461 A	500 kg	CMI	Report in progress, Draft B	2001-2005
EUROMET.M.P-S1	788 A	0.05 MPa to 1 MPa	METAS	Approved and Published	2004-2005
EUROMET.M.P-S2	922 C	30 Pa to 7 kPa	PTB	Approved and Published	2006
EUROMET.M.P-S3	884 C	80 kPa to 110 kPa	LNE	Approved and Published	2006
EUROMET.M.P-S4	861 C	0.04 MPa to 1.75 MPa	LNE	Approved and Published	2006
EUROMET.M.P-S5	931 C	50 MPa to 500 MPa	PTB	Report in progress, Draft B	2007
EUROMET.M.P-S6		1.5 kPa to 300 kPa	PTB	Approved and Published	2007
EUROMET.M.P-S7	1040 C	0.1 mPa to 1 Pa	PTB	Approved and Published	2007
EUROMET.M.T-S1	1055 C	1 N.m to 1000 N.m	PTB	In progress	2008
EUROMET.M.F-S1		500 kN	NPL	Published	2005-2006

4. CMCs

Over the last year CMC activities within the TC-M have included the review of eight CMCs from other RMOs.

EURAMET.M.7.2007, which was posted in August 2007 was finally approved by all reviewing RMOs and the CMCs concerned were published. The review of this group of CMCs raised a number of issues with the review process, which were discussed at the CCM CMC Working Group meeting in June 2008. Because the submission contained a number of CMCs from different NMIs and technical areas the review process had been slow. Additional concerns were raised about the lack of consistency in the review process between RMOs.

EURAMET.M.9.2008 (PTB Pressure CMC revision) was submitted for RMO review in October 2008. Comments were received from SIM, AFRIMETS and APMP. Minor modifications are required as is a translation of an accompanying document. These will be submitted this month.

EURAMET.M.10.2008 (METAS Pressure CMC revision) was submitted for RMO review in October 2008, the proposed changes have been agreed by all (reviewing) RMOs and the database should be updated once the final endorsement has been received from SIM

New CMC submissions from NIS, Egypt in the technical areas of Mass, Force, Pressure and Viscosity have been approved by EURAMET and have been submitted for review by the other RMOs.

A peer review visit to was made to NPL Israel by Ulf Jacobsson (TC-M Mass area Technical Assessor) to review facilities in connection with proposed mass CMC submissions from NPL Israel.

New CMC in the field of torque have been received from CEM, Spain. These are currently undergoing reviewed within EURAMET.

At the last CCM meeting Dr Chris Sutton (Chair CCM WG CMC) presented a proposal to expand the current classification of services for mass and related quantities to include specific instruments. This will have a number of benefits.

- It will make it easier to include the uncertainty of device under calibration,
- it will allow NMIs to be more specific about their services,
- it will more clearly show the traceability path from a client's measurement result back to one or more CMCs.

Further, it is possible that the expanded classification may be useful for the laboratory accreditation bodies. The intention is for existing CMCs to remain valid under the expanded classification. NMIs will then have the option of modifying their existing CMCs to more clearly present their capabilities.

5. Activities of the Sub-Committees

The Sub-committees in the TC-M area are Mass, Force, Pressure and Density additionally technical experts have been nominated in the areas of Hardness, Gravimetry and Viscosity to assist with the review of CMC and project proposals.

Mass, Force, Pressure and Density sub-committees meet annually before the TC-M Contact Persons meeting. At this year's technical meetings the following subjects were discussed.

Mass Sub-Committee

Progress on Projects 786 ((sub-)multiples of the kilogram) and 839 (500 kg mass comparison). A workshop on weighing in vacuum, cleaning of primary mass standards and automation of mass calibration facilities was held. The updating of EURAMET Calibration Guidance Document 18 (Guidelines on the Calibration of Non-Automatic Weighing Instruments) was discussed. The results of an SEE (South Eastern Europe Metrology Initiative) mass comparison were also presented.

Force Sub-Committee

Progress on Projects 518 (100 kN comparison), 285 and 286 (traceability) and 505 (1 MN and 4 MN comparisons). A workshop was held on dynamic force measurement (Project 890). The updating of EURAMET Calibration Guidance Document 04 (Uncertainty of Calibration Results in Force Measurements) was also discussed (Project 887).

Pressure Sub-Committee

Progress on Projects 803 (FPG-type digital piston manometer – exchange of experiences), 911 (standard leaks), 1039 (FEA of pressure balances), 1040 (0.1 mPa to 1 Pa comparison), 1041 (200 kPa Comparison),

1047 (0.5 Pa to 15 kPa comparison) and 1091 (50 MPa to 500 MPa comparison). The updating of EURAMET Calibration Guidance Document 03 (Calibration of Pressure Balances) was also discussed. The results of an SEE (South Eastern Europe Metrology Initiative) pressure comparison were also presented.

Density Sub-Committee

Progress on Project 1019 (Liquid density comparison) and 1031 (solid density comparison) were discussed. Additionally a presentation on CMC tables and the review process was given.

6. Participation in iMERA-Plus

The TC-M membership is involved with two EMPR Joint Research Projects namely;

- T1.J1.1 “e-MASS” The watt balance route towards a new definition of the kilogram
- T1.J1.2 “NAH” Avogadro and molar Planck constants for the redefinition of the kilogram

Additional the TC-M is involved in aspects of T1.J1.4 “Boltzmann constant” Determination of the Boltzmann constant for the redefinition of the Kelvin.

The need for collaboration or research both within the TC-M and across technical committees was discussed at the last Contact Persons meeting. IMERA roadmaps in the technical areas of Mass, Force, Pressure and Dynamic Measurement were also reviewed and updated. A session will be held at the next Contact Persons meeting to outline strategy and discuss possible collaborations with particular respect to the EMRP.

7. Meetings

The Mass and related quantities TC Contact Persons meeting for 2009 was held at in Attard, Malta from the 5th to the 6th of March. The meeting included eight technical sessions to review progress in projects in the fields of mass, force, pressure, density. Additionally dynamic measurement, the EURAMET Guidance Documents and iMERA roadmaps were discussed.

The TC meeting was attended by 71 delegates from 31 countries and also included representatives from the European Commission (IRMM) and the BIPM.



The next EURAMET TC-M Contact Persons meeting will take place from 3rd to 5th March 2010 in Istanbul Turkey. It has been proposed to extend the meeting to 3 days to allow for more extensive technical meetings and strategy planning within the technical area.

A meeting "Analysis of Dynamic Measurements" was held at NPL on the 18th of November 2008 to discuss dynamic measurement (particularly with respect to the mechanical metrology area). Presentations included:

- So what is it that's dynamic about dynamic measurements? (Trevor Esward, NPL)
- Development and investigation of new force sensors for dynamic measurements (Andre Buss, PTB Braunschweig, Germany)
- Analysis and synthesis of speed-limiting road humps (Peter Hessling, SP, Sweden)
- Applied measurement of the dynamic characteristics structures using non-contact laser vibrometry (Roger Traynor, Polytec Ltd, UK)
- Analysis and uncertainty evaluation of dynamic measurements modelled by LTI systems (Clemens Elster, PTB, Berlin, Germany)
- Comparison of two approaches for the evaluation of dynamic uncertainties (Sascha Eichstadt, PTB, Berlin, Germany)
- Propagation of uncertainty for discrete- time LTI systems using a state-space approach (Alfred Link, PTB, Berlin, Germany)
- On the equivalence of sine and shock force measurements (Michael Kobusch, PTB, Braunschweig, Germany)

8. Issues

EURAMET Calibration Guidance Document

All EA Calibration Guidance Documents have been transferred across to EURAMET. Two documents, cg 03 Calibration of Pressure Balances and cg 04 Uncertainty of Calibration Results in Force Measurements are currently being updated. The contents of cg 03 were extensively discussed at the recent TC-M Contact Persons meeting and it is hoped that a finalised version will be available in the summer. The finalisation of cg 04 is waiting the publication of ISO 376 Metallic materials -- Calibration of force-proving instruments used for the verification of uniaxial testing machines to which it will refer extensively. It is hoped that the new version of cg 04 will also be available in the summer.

EURAMET Calibration Guide 18 Guidelines on the Calibration of Non-Automatic Weighing Instruments has been revised and version 02 has been produced. The revision of the document addressed a number of errors in the original guide and updated data on air density measurement (including reference to the new CIPM2 2007 formula for calculating the density of moist air). The revision of the guide was undertaken in collaboration between SIM and EURAMET and was completed in about 3 months. The guide is used extensively in the SIM areas (particularly in South America) and so the timely revision of the guide was essential to its continued use in the area. Thanks should go to Luis Omar Becerra at CENAM, Mexico for his extensive work on this revision.

Redefinition of the kilogram

The target date for the redefinition is still the CIPM meeting in 2011. The CCM met in March to review the status of the various redefinition projects and to draft its report to the CIPM. The report made the following recommendations;

- At least three independent experimental results should yield values of the relevant constants with relative uncertainties no larger than 5 parts in 10^8 . One of these results should be derived from work being carried out by the International Avogadro Coordination project. At least one of these results should have a relative standard uncertainty no larger than 2 parts in 10^8 ;
- Values of the Planck and Avogadro constants obtained from the Avogadro experiment and the watt balance experiments should be consistent at the 95 % level of confidence;
- When the above conditions are met, the subsequent redefinition of the kilogram shall be based on the values of fundamental constants being recommended by CODATA;
- After redefinition of the kilogram, means of making an experimental link to the Planck constant or the mass of a suitable atomic or elementary particle must be maintained and simplified; although it is premature to specify how many experimental facilities will be required, at least one of these experiments should be able to make this link with a relative standard uncertainty no larger than 2 parts in 10^8 ;
- The creation of a workable *mise en pratique* for realizing the new unit of mass with the required continuity and stability is considered to be of crucial importance. However, until more experimental evidence is in hand, it is premature to specify a precise *mise en pratique*
- If all above conditions are met, there should be minimal impact to stakeholders in the field of mass metrology.

CCM Task Groups have been set up within the Mass WG to address the issues of Mass metrology under vacuum for a *mise en pratique* (TG1) and Uncertainty components due to traceability to the international prototype of the kilogram (TG2). Both TGs are chaired by members of the TC-M. A comparison of weights in vacuum has been initiated between four EURAMET NMIs to address the requirements of TG1.

Good progress has been made on both the Avogadro and Watt balance projects. A new value for the isotopic content of natural silicon has been determined bringing the Avogadro Number (N_A) into agreement with the CODATA value of Planck's constant (albeit at an uncertainty of 1 in 10^7). Measurements of the isotopic composition of enriched Silicon 28 are underway with a target uncertainty of 2 in 10^8 .

9. Strategic planning

Several areas of collaborative research are being explored within the TC0M area including dynamic measurement, kilogram mise-en-pratique, FEA modelling for pressure balances and micro- and nano- mass and force measurements. Strategic planning was discussed at the last TC-M Contact persons meeting and it was emphasised that future collaboration should be across technical areas within the TC and also include other TCs. The example of the Boltzmann redefinition project was given as an area where TC-M members were collaborating with colleagues in the thermal area. The need to plan for collaboration on cross TC projects was seen to be necessary, particularly in respect of EMRP proposals. Areas identified for collaboration included;

- Dynamic measurement
- Energy and Environment
- Health
- Transport

A session will be held at the next Contact Persons meeting to address strategic planning in these (and other) areas. At the last CP meeting IMERA roadmaps in the technical areas of Mass, Force, Pressure and Dynamic Measurement were also reviewed and updated

10. Outlook for 2009/2010

Several new comparisons are underway in the areas of pressure and also liquid density. New collaborations in the mass areas (on micro-mass and on weighing in vacuum) are underway and thought is being given to strategic planning to allow cross-technical area and cross-TC collaboration on sector relevant research projects.

The redefinition of the kilogram has come a step closed with the re-determination of the isotopic composition of natural silicon meaning that the Avogadro Constant is now in agreement with the CODATA value of Planck's constant. Work continues on both the Avogadro and watt balance projects and on the development of a mise-en-pratique for the kilogram redefinition.

Walter Bich of INRiM will take over as chairman of the TC-M after the EURAMET General Assembly.

Stuart Davidson, NPL
TC-M Chairman