



EUROMET Mass & Related Quantities

Annual report 2002/2003

1. General aspects

The work in EUROMET field “Mass & Related Quantities” is still focused on organizing and participating in regional key and supplementary comparisons in support of the MRA. After a first round of publishing CMC tables in the KCDB, the workload on internal and interregional review of CMC tables has lowered. However, an increase in the workload is foreseen for the coming years as many EUROMET countries plan to submit new entries or modify existing entries as key comparisons supporting such entries are being completed.

The first implications of the MRA are emerging. One major issue in the mass field has been the fact that European accreditation bodies will not accept calibration certificates stating a smaller uncertainty than that claimed by the NMI to which the laboratory issuing the certificate is traceable. As a consequence, NMIs cannot issue acceptable certificates with uncertainties smaller than what they have claimed in the CMC tables, even though CMC tables are for routine calibrations and the NMI may be able to do a better job, if requested.

Scientifically, the trend in the field is that more laboratories are getting involved in activities related to a new definition of the kilogram, such as the Avogadro project, the Watt experiment, the ion accumulation experiment, and the magnetic levitation experiment. These activities are typically not covered by EUROMET projects, but are carried out by individual laboratories. However, the EUROMET TC Mass annual meeting provides an excellent forum for the exchange of scientific information, which is highly valued by the participants.

In dissemination of traceability, the trend is to increase efficiency and reduce costs by automating and computerizing the calibration work.

2. Meetings

The annual EUROMET Mass & RQ TC meeting took place in Bern, 27-28 February 2003. A total of 41 contact persons and project coordinators representing 27 countries plus the BIPM participated in the meeting that was hosted by the Swiss metrology institute METAS. At this meeting, status on EUROMET projects, regional key comparisons and interregional review of CMC tables was reported.



3. Projects

There are currently 26 agreed projects in the field of Mass & Related Quantities. Since the last General Assembly, three projects have been completed; one of these (project no.336) was the so-called Avogadro project, which is the only project in the field having received EU funding. The activity will be continued under the CCM Working Group on the Avogadro Constant.

Additionally four projects are currently proposed. The 33 projects are listed in Annex 1 sorted after the subfields *Mass, Density, Pressure, Force, Viscosity, Hardness* and *Others*. The distribution of the 33 projects over type of collaboration and over current status is shown in table 1. The distribution of the projects over the subfields is shown in figure 1. The trend in the number of projects sorted after type of collaboration is shown in figure 2. Note that the number of cooperation projects continues to increase whereas the number of the other types of projects seems to stabilize.

	Completed	Agreed	Proposed	Total
Cooperation	3 projects No. 336, 551, 598	10 projects: No. 113, 144, 351, 402, 463, 499, 509, 519, 534, 604	3 projects: No. 675, 676, ???	16 projects
Comparison	No projects	10 projects: No. 439, 442, 445, 461, 505, 510, 518, 535, 627, 650	1 project No. 702	11 projects
Traceability	No projects	5 projects: No. 005, 026, 138, 285, 286	No projects	5 projects
Consultation	No projects	1 project No. 697	No projects	1 project
Total	3 projects	26 projects	4 projects	33 projects

Table 1. Status on EUROMET Mass & RQ projects as per 2003-05-01. The projects are grouped according to the project status (Completed, agreed, proposed) and type of collaboration (Cooperation in research, comparison of measurement standards, traceability, consultation on facilities). The completed projects include only those that were active in 2002/2003.

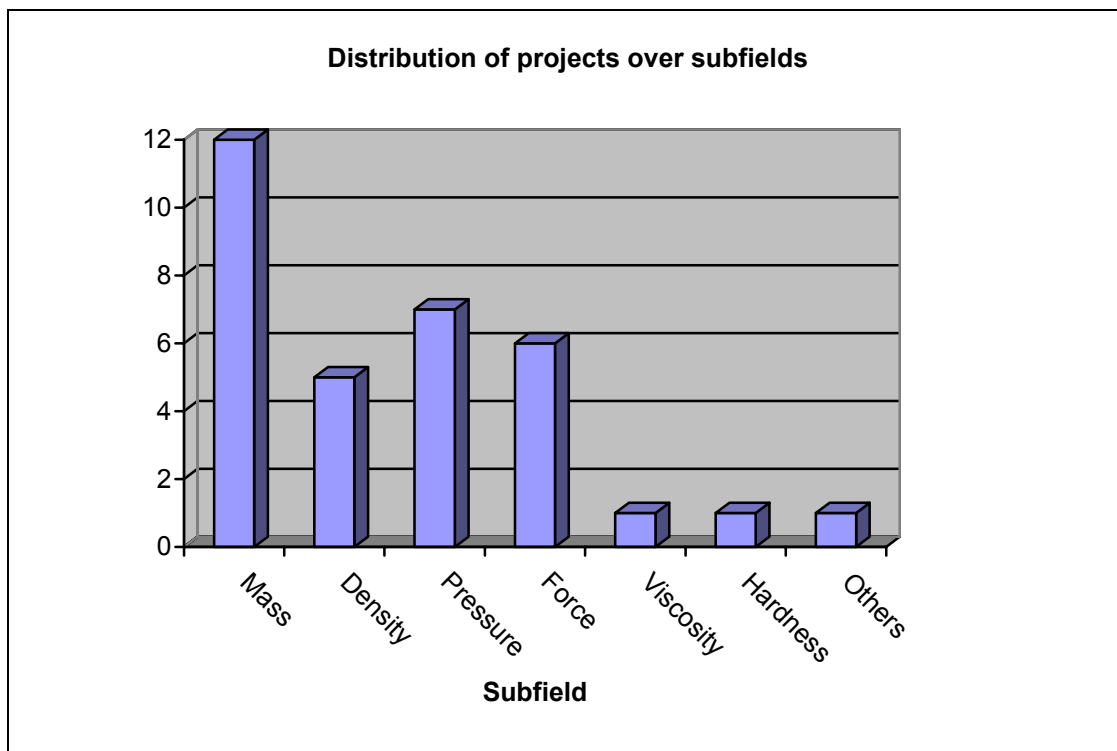


Figure 1. *Distribution of EUROMET Mass & RQ projects over subfields*

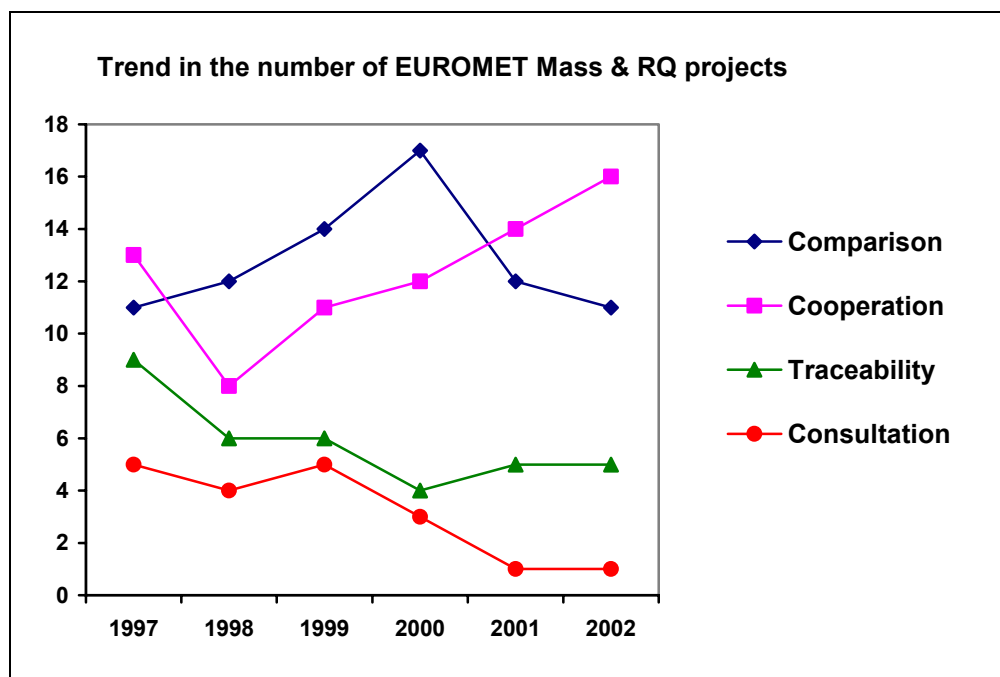


Figure 2. *Trend in the number of EUROMET Mass & RQ projects sorted after type of collaboration.*



4. Mutual Recognition Arrangement

4.1 Key and supplementary comparisons

The BIPM Key Comparison Database contains 57 CIPM Key Comparisons and 6 CIPM Supplementary Comparisons. The distribution of these comparisons over subfields is shown in table 2. The numbers of comparisons in which EUROMET is represented are shown in brackets. In general, the number of EUROMET participants in CIPM comparisons is sufficient to provide a strong link between EUROMET and CIPM comparisons. Unfortunately the reporting time for CIPM comparisons is very long. It is not clear what causes the delay, but the absence of a commonly agreed method for analysing the results of key comparisons may be an important factor.

	Mass	Density	Pressure	Force	Viscosity	Hardness
No. of KC's	5 (3)	4 (4)	13 (13)	26 (22)	5 (5)	4 (4)
No. of SC's	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	6 (6)

Table 2. The number of CIPM key (KC) and supplementary (SC) comparisons in the different subfields. The numbers in brackets are the number of comparisons in which EUROMET is represented.

The EUROMET Key and Supplementary Comparisons are listed in table 3 and 4. The completed key comparisons are those for which status is either “Approved for equivalence” (relevant for key comparisons that can be linked to a CIPM key comparison) or “Approved for provisional equivalence” (relevant for old EUROMET comparisons that cannot be linked to a CIPM key comparison). As for the CIPM comparisons, the time needed to complete EUROMET comparisons is generally very long. For some of the comparisons, the part that remains is only the linking of the EUROMET comparison to the relevant CIPM comparison. Again, the absence of a commonly agreed method for linking CIPM and RMO key comparisons tends to delay the final reporting of the EUROMET comparisons.

An ongoing EUROMET comparison (project no. 461) in which the conventional value of mass of a 500 kg weight is measured has just been registered as a supplementary comparison. As there is no similar CIPM comparison to be linked to, the comparison cannot be registered as a key comparison. As a result of the registration process, it was realized that there are no rules for conducting supplementary comparisons and that the registration was almost a formality. All EUROMET comparisons that do not meet the criteria of a key comparison, but nevertheless may support uncertainties claimed in CMC tables, should therefore be registered as supplementary comparisons.



Comparison ID	Project no.	Subfield	No. of part.	Pilot	Status	Years
EUROMET.M.M-K1	215 C	Mass	10	NPL	Report in progress	1992-1999
EUROMET.M.M-K2	445 A	Mass	23	SP	In progress	2001-2003
EUROMET.M.M-K4	510 A	Mass	17	NPL	In progress	1999-2003
EUROMET.M.D-K1	339 C	Density	12	METAS	Provisional equivalence	1998-1999
EUROMET.M.D-K2.Prev	236 C	Density	5	IMGC	Provisional equivalence	1993-1994
EUROMET.M.D-K2	627 A	Density	8	PTB	Measurements completed	2001-2002
EUROMET.M.D-K?	702 P	Density		IMGC	Planned	2003-
EUROMET.M.P-K1.a	442 A	Pressure	12	BNM-LNE	Measurements completed	1999-2002
EUROMET.M.P-K1.b	442 A	Pressure	12	BNM-LNE	Measurements completed	2000-2002
EUROMET.M.P-K2	305 C	Pressure	6	PTB	Approved for equivalence	1994-1995
EUROMET.M.P-K3.a	439 A	Pressure	8	LNE/NPL	Draft A in progress	1999-2001
EUROMET.M.P-K3.b	439 A	Pressure	11	NPL	Draft A in progress	1999-2001
EUROMET.M.P-K4	389 C	Pressure	14	NPL	Draft B in progress	1998-1999
EUROMET.M.P-K5	045 C	Pressure	7	BNM-LNE	Provisional equivalence	1993-1995
EUROMET.M.P-K6	110 C	Pressure	6	BNM-LNE	Provisional equivalence	1992-1994
EUROMET.M.F-K1	535 A	Force	9	MIKES	In progress	2002-2004
EUROMET.M.F-K2	518 A	Force	10	NPL	Planned	2003-2005
EUROMET.M.F-K3	505 A	Force	11	PTB	In progress	2000-2003

Table 3. *EUROMET key comparisons*

Comparison ID	Project no.	Subfield	No. of partic.	Pilot	Status	Years
EUROMET.M.V-S1	273 C	Viscosity	4	PTB	Published	1992-1993
EUROMET.M.V-S2	303 C	Viscosity	5	PTB	Published	1993-1996
EUROMET.M.V-S3	415 C	Viscosity	12	PTB	Published	2000
EUROMET.M.M-S1	461 A	Mass	18	CMI	In progress	2001-2003

Table. 4 *EUROMET supplementary comparisons*



4.2 Calibration and measurement capabilities

The status of the interregional review of CMC tables is shown in table 5. Compared to last year, the major part of the tables is now published in the Key Comparison Database at BIPM. The two APMP CMC submissions under current review have been accepted by EUROMET, except for the hardness entries, which are still being discussed.

It is not clear what is upholding the publication of the CMC tables from SADCMET, which were reviewed by EUROMET in 2001.

The EUROMET CMC submission under current review contains the EUROMET viscosity tables, which has been harmonised in accordance with a decision in the Ad Hoc Working Group on Viscosity set up by the BIPM. The tables are therefore expected to be accepted without any further discussion.

Several EUROMET members have sent or will send new or modified CMC entries in the field of Mass & Related Quantities. In order to improve the efficiency of the internal and interregional review, the TC Mass has decided to set September 1, 2003 as a deadline for submission of CMC entries for the next round of review.



CMC identifier	RMO	Description	Status	Date
APMP.M.1.2001	APMP	Mass, force, pressure, density, and hardness from 7 APMP members (including NIM, China)	Published in KCDB	2002-03-27
APMP.M.2.2002	APMP	Mass and pressure from SIRIM (Malaysia)	Published in KCDB	2002-06-10
APMP.M.3.2001	APMP	Mass, force and pressure from Japan	Published in KCDB	2002-08-12
APMP.M.4.2002	APMP	Mass, force, pressure and hardness from Japan	Review in progress	2003-02-21
APMP.M.5.2002	APMP	Mass, pressure and hardness from CMS/ITRI (Chinese Taipei)	Review in progress	2003-02-21
COOMET.M.1.2001	COOMET	Mass, force and pressure from Russia	Published in KCDB	2002-09-25
COOMET.M.2.2001	COOMET	Viscosity from Russia	Published in KCDB	2002-09-15
COOMET.M.3.2001	COOMET	Force from Russia	Published in KCDB	2002-09-25
EUROMET.M.1.2001	EUROMET	Mass, density, pressure, force, torque, viscosity, and gravimetry from 21 countries	Published in KCDB	2002-06-26
EUROMET.M.3.2003	EUROMET	Modification of viscosity from 9 countries	Review in progress	2003-05-01
SADCMET.M.1.2001	SADCMET	Mass and density from CSIR-NML (ZA)	Review in progress	2003-05-01
SADCMET.M.2.2001	SADCMET	Pressure from CSIR-NML (ZA)	Review in progress	2003-05-01
SADCMET.M.3.2001	SADCMET	Force, torque and hardness from CSIR-NML (ZA)	Review in progress	2003-05-01
SIM.M.1.2001	SIM	Mass, force, torque, hardness, pressure and density	Published in KCDB	2002-06-18

Table 5. Status on the interregional review of CMC tables for appendix C of the MRA



Appendix 1. List of EUROMET Mass & RQ projects sorted after subfields

Subfield: Mass

Number of Project	Coordinator	Title and participants	Report
336 C Type: Cooperation EC funded	Becker (DE)	Primary mass standards based on atomic mass CEC, DE, IT, SE	Final report 05.03.03
351 A Type: Cooperation	Gosset (FR)	Workshop on "Secondary & reference mass standards" (BIPM) CZ, DE, DK, ES, FI, FR, GB, IT, NL, NO, SE, TR	Ongoing 03.12.01
402 A Type: Cooperation	Spurný (SK)	Mass measurement (Guide to the mass determination) CZ, DK, ES, FI, FR, GB, IT, NL, NO, SE, SK, TR	Ongoing 11.02.00
445 A Type: Comparison	Jacobsson (SE)	Comparison of mass standards in multiples and sub-multiples of the kilogram BE, ES, IE, FI, IS, DK, DE, FR, GB, IT, SE, NO, PT, NL, CH, PL, HU, CZ, SK, LT, AT, SL, GR, TR, RO, BG, LV EE	Ongoing 04.03.03
461 A Type: Comparison	Kriz (CZ)	Comparison of 500 kg mass standard weight AT, BE, CH, CZ, DK, ES, FI, GB, GR, HU, IT, IE, NO, SE, SI, TR	Ongoing 26.02.03
509 A Type: Cooperation	Davidson (GB)	Intercomparison of Pt-Ir kilogram standards AT, (BIPM), BE, CH, CZ, DE, DK, ES, FI, FR, GB, HU, IT, NO, PL, SE, SI, SK, TR	Ongoing 05.03.03
510 A Type: Comparison	Davidson (GB)	Comparison of mass standards of the kilogram (stainless steel) AT, BE, CH, CZ, DE, DK, ES, FI, FR, GB, HU, IE, IS, IT, NL, NO, PT, SI, SK, TR	Ongoing 05.03.03
519 A Type: Cooperation	Khelifa (FR)	Correlations between air humidity & abnormal dispersion of refractive index of air (BIPM), DE, DK, FR, GB, IT, SE	Ongoing 10.12.01



551 C Type: Cooperation	Pinot (FR)	Study of several roughness measurement techniques for the characterisation of mass standard FR, SE, USA	Final report 26.02.03
598 C Type: Cooperation	Glaeser (DE)	Investigation of magnetic interactions between mass standards and weighing instruments CH, DE, ES, FI, FR, GB, SE	Final report 04.04.03
697 A Type: Consultation	Bartolo (MA)	Setting up a mass lab from 1 mg to 10 kg at E1 level IT MA	Starting 05.02.03
7?? P Type: Cooperation	Pinot (FR)	Study of materials for the realization of mass standards (BIPM) CH FR SE	Starting 01-04-03

Subfield: Density

Number of Project	Coordinator	Title and participants	Report
138 A Type: Traceability	Bettin (DE)	Calibration of master hydrometers DE, GB	Ongoing 30.11.01
144 A Type: Cooperation	Gläser (DE)	Measurement of air density using specially designed masses (BIPM), DE, GB, SE	Ongoing 26.02.02
627 A Type: Comparison	Bettin (DE)	Comparison of density determinations of liquid samples DE, FI, FR, HU, IT, PL, ZA	Ongoing 30.11.01
675 P Type: Cooperation	Verbeek (NL)	Validation of facilities for density determinations of solids NL, EST	Starting 01.07.03
702 P Type: Comparison	Lorefice (IT)	Comparison of high resolution hydrometers for liquid density determination IT AT DE FI FR HU PL PT RU SL TR	Starting 01.07.03



Subfield: Pressure

Number of Project	Coordinator	Title and participants	Report
439 A Type: Comparison	Severn (GB)	Pressure standard comparisons, gas media and gauge mode from 50 kPa to 7 MPa AT, BG, CZ, DE, DK, ES, FI, FR, GB, HU, IE, IT, NL, PL, PT, RU, SE, SK, TR, ZA	Ongoing 17.03.03
442 A Type: Comparison	Legras (FR)	Comparison in the low pressure range $1 \cdot 10^{-4}$ Pa to 1000 Pa BE, BG, CZ, DE, ES, FI, FR, GB, HU, IT, LT, NL, SE, SI, SK, TR	Ongoing 10.12.01
463 A Type: Cooperation	Sabuga (DE)	Calculation of elastic distortion and associated uncertainty in piston cylinders operating up to 1 GPa DE, FR, GB, IT, SK, TR	Ongoing 03.03.03
499 A Type: Cooperation	Verbeek (GB)	Bulletin-board of concerns, problems and experiences BE, CH, DE, DK, ES, FI, FR, GB, GR, HU, IE, IT, NL, NO, PL, PT, SE, TR, ZA	Ongoing 18.04.02
534 A Type: Cooperation	Tesar (CZ)	Low pressure digital piston manometer with nominal effective area 100 cm ² CZ, DE, GB, IE, SE	Ongoing 17.02.02
650 A Type: Comparison	Rantanen (FI)	Interlaboratory comparison in the pressure range 0 to 13000 Pa (differential mode), and 0,1 to 13000 Pa (absolute mode).	Starting: 02.01.02
676 P Type: Cooperation	Jescheck (DE)	Investigations on the force controlled piston gauge FPG8601 with non-rotating piston of nominal area 980 mm ² FI, DE	Starting 26.08.02



Subfield: Force

Number of Project	Coordinator	Title and participants	Report
113 A Type: Cooperation	Ferrero (IT)	Force multi-component DE, FI, FR, GB, IT, PT, TR	Ongoing 03.04.00
285 A Type: Traceability	Sawla (DE)	Calibration of precision force measuring devices and transfer standards of the capacities up to 16,5 MN DE, DK, FI, GB, IT, SE, TR	Ongoing 11.12.00
286 A Type: Traceability	Sawla (DE)	Traceability in force measurement at national laboratory level in range up to 2MN DE, FI, SE, TR	Ongoing 11.12.00
505 A Type: Comparison	Kumme (DE)	Comparison of force standards from 500 kN to 4 MN BE, CH, CZ, DE, ES, FI, GB, HU, IT, PL, SE, TR	Ongoing 13.12.00
518 A Type: Comparison	Knott (GB)	An intercomparison of force standards at 50 kN and 100 kN AT, CH, CZ, DE, GB, GR, HU, NL, PL, PT	To start: 01.01.03
535 A Type: Key comparison (regional)	Pusa (FI)	Intercomparison of force standards at 5 kN and 10 kN CH, CZ, DE, FI, HU, IT, PL, PT, SE,	To start: 01.01.02



Subfield: Viscosity

Number of Project	Coordinator	Title and participants	Report
005 A Type: Traceability	Klingenberg (DE)	Viscosity measurement services DE, GB	Ongoing 29.01.03

Subfield: Hardness

Number of Project	Coordinator	Title and participants	Report
26 A Type: Traceability	Germak (IT)	Hardness standards GB, IT	Ongoing 18.01.02

Subfield: Others

Number of Project	Coordinator	Title and participants	Report
604 A Type: Cooperation	Leggat (GB)	Comparison issues AT, BE, CEC, CZ, DK, FI, FR, DE, GR, HU, IS, IE, IT, NL, NO, PL, PT, SK, SI, ES, SE, CH, TR, GB	Ongoing 20.11.00