

EURAMET
European Association of National Metrology Institutes

Highlights and Challenges in Mass and Related Quantities

2010-2011 TC-M Report to the General Assembly



Walter Bich, TC-M Chair
INRiM, Italy

5th EURAMET General Assembly,
6-9 June 2011, Sarajevo

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General

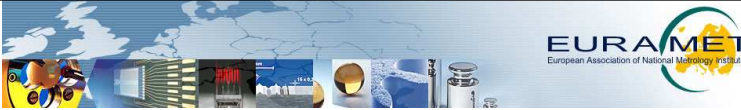
- Many very different quantities
- Three sub-fields: mass (with density), force (gravimetry, hardness), pressure
- No separate meetings (so far), just technical sessions before the TC-CP meeting
- Last TC-M contact persons meeting – San Anton, Malta, 2 to 4 March 2011.

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Projects

135 overall (104 completed, 2 cancelled)

9 new since the last GA (7 comparisons, 2 research)



7 completed during the last year (3 comparisons, 3 research, 1 traceability)

Highlights:
 sub-milligram standards
 Magnetic properties of mass standards

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Projects

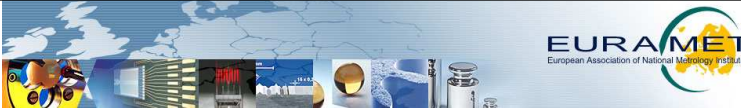
	Comparison	Research	Traceability	Consultation	Total
Proposed	2 (4)	1 (3)	-	-	3 (7)
Agreed	17 (15)	7 (9)	2 (3)	/ (/)	26 (27)
Completed+ cancelled	46+1 (43)	36+1 (33)	7 (6)	15 (15)	104+2 (97)
Total	66 (62)	45 (45)	9 (9)	15 (15)	135 (131)

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Project breakdown


	Proposed	Agreed	Completed/canc.	Total
Density	1 (1)	1 (3)	8 (7)	10
Force	1 (2)	6 (7)	6+1 (5)	13
Hardness			1 (1)	1
Mass		7 (7)	40 (39)	47
Pressure	1 (5)	10 (6)	41 (39)	52
Torque		1 (2)	2+1 (1)	4
Viscosity		1 (1)	5 (4)	5
Gravimetry	1 (1)	1 (1)	1 (1)	3

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14 active projects (non KCs)

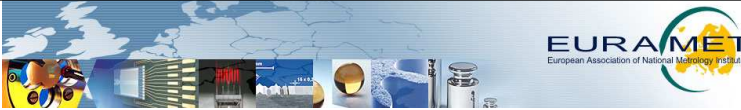
Ref.	Title	Institute	Year	Collaboration
285	Calibration of precision force measuring devices and transfer standards of the capacities up to 16,5 MN.	PTB	1993	traceability
286	Traceability in force measurement at national laboratory level in range up to 2 MN	PTB	1993	traceability
351	Workshop on 'Secondary and Reference Mass Standard'	LNE	1995	research
402	Mass measurement (Guide to the mass determination).	SMU	1997	research
518	An intercomparison of force standards at 50 kN and 100 kN	NPL	2003	comparison
803	FPG-type digital piston manometer – exchange of experiences	MIKES	2004	research
838	Bilateral Comparison of Force Standard Machines	UME	2005	comparison
890	Dynamic Force Measurement	PTB	2006	research
911	Study of standard leaks performance for different gas, in the transition regime	INRIM	2006	research
1030	Second regional (European) Comparison of Absolute Gravimeters (ECAG-2007)	INRIM	2008	comparison
1097	Bilateral comparison on Force measurement at: 0 kN, 5 kN, 10 kN	BIM-NCM	2008	comparison
1110	Determination of magnetic properties of mass standards	PTB	2009	research
1115	R-134a leak comparison in atmospheric pressure	LNE	2010	comparison
1121	Transferring of knowledge in the field of gas pressure balance calibration	EIM	2009	research

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31 Key Comparisons

Comparison ID	Project no.	Title/Range	Subfield	Pilot	Status	Years
EUROMET.M.M-K1	215	Kilogram	Mass	NPL	Approved for equivalence	1992-1999
EUROMET.M.M-K2	445	(Sub-)multiples	Mass	SP	Approved for equivalence	2001-2003
EUROMET.M.M-K2.1	786	(Sub-)multiples	Mass	SP	Approved for equivalence	2004-2008
EUROMET.M.M-K4	510	Kilogram	Mass	NPL	Approved for equivalence	1999-2003
EUROMET.M.M-K4.1	1029	Kilogram	Mass	MIRS	Approved for equivalence	2007-2008
EURAMET.M.M-K4.2	1120	Kilogram	Mass	BEV	Report in progress, Draft B	2009-2011
EURAMET.M.M-K2.2	1120	(Sub-)multiples	Mass	BEV	Report in progress, Draft B	2009-2011
EUROMET.M.D-K1	339	Solid (3 Si spheres)	Density	METAS	Provisional equivalence	1998-1999
EUROMET.M.D-K1.1	1031	Solid (3 ceramic sph.)	Density	PTB	In progress	2008-2010
EUROMET.M.D-K2	627	Liquid density	Density	PTB	Report in progress, Draft B	2001-2002
EURAMET.M.D-K2	1019	Liquid density	Density	BEV	In progress, Draft A	2007-
EUROMET.M.D-K4.Prev	236	Hydrometers	Density	IMGC	Provisional equivalence	1993-1994
EUROMET.M.D-K4	702	Hydrometers	Density	IMGC	Approved for equivalence	2003-2006
EUROMET.M.P-K1.a	442	0.1 Pa to 1000 Pa	Pressure	BNM-LNE	Approved for equivalence	1999-2002
EUROMET.M.P-K1.b	442	0.3 mPa to 9 Pa	Pressure	BNM-LNE	Approved for equivalence	2000-2002

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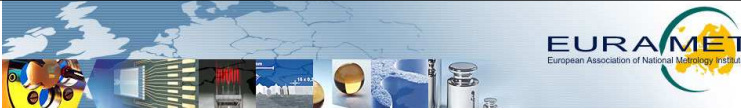


31 Key Comparisons (follows)

Comparison ID	Project no.	Title/Range	Subfield	Pilot	Status	Years
EUROMET.M.P-K2	305	1 MPa to 4 MPa	Pressure	PTB	Approved for equivalence	1994-1995
EUROMET.M.P-K3.a	439	0.05 MPa to 1 MPa	Pressure	LNE/NPL	Approved for equivalence	1999-2001
EUROMET.M.P-K3.b	439	0.05 MPa to 1 MPa	Pressure	NPL	Approved for equivalence	1999-2001
EUROMET.M.P-K4	389	10 MPa to 100 MPa	Pressure	NPL	Approved for equivalence	1998-1999
EURAMET.M.P-K4 2010	1047	0.5 Pa to 15 kPa	Pressure	CMI	In progress	2007
EUROMET.M.P-K5	045	50 MPa to 500 MPa	Pressure	BNM-LNE	Provisional equivalence	1993-1995
EUROMET.M.P-K6	110	100 MPa - 1000 MPa	Pressure	BNM-LNE	Provisional equivalence	1992-1994
EURAMET.M.P-K7	881	50 MPa to 500 MPa	Pressure	MIKES	Report in progress, Draft B	2005-2007
EURAMET.M.P-K8	1041	25 kPa to 200 kPa	Pressure	METAS	In progress	2007-
EURAMET.M.P-K13	1091	50 MPa to 500 MPa	Pressure	UME	In progress	2009-
EURAMET.M.P-K1.c	1179	0.7 MPa to 7 MPa	Pressure	FORCE	In progress	2011
EUROMET.M.F-K1	535	5 kN to 10 kN	Force	MIKES	Report in progress, Draft B	2002-2004
EUROMET.M.F-K2	518	50 kN to 100 kN	Force	NPL	Rep. in progress, Draft B	2003-
EUROMET.M.F-K3	505	500 kN to 4 MN	Force	PTB	Proposed	2005-2007
SIM-EUROMET.M.P-BK3		3 mPa to 0.9 Pa	Pressure	PTB/CENAM	Approved for equivalence	2001-2002
SIM-EUROMET.M.P-BK4		10 MPa to 100 MPa	Pressure	PTB/CENAM	Approved and Published	2002

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21 Supplementary Comparisons

Comparison ID	Project no.	Title/Range	Subfield	Pilot	Status	Years
EUROMET.M.V-S1	273	(0.989-4600) mm ² /s	Viscosity	PTB	Published	1992-1993
EUROMET.M.V-S2	303	(0.4- 67743) mm ² /s	Viscosity	PTB	Published	1993-1996
EUROMET.M.V-S3	415	(190- 774000) mm ² /s	Viscosity	PTB	Published	1997-2000
EUROMET.M.V-S4	415	(0.33-144000) mm ² /s	Viscosity	PTB	Published	1997
EUROMET.M.M-S1	461	500 kg	Mass	CMI	Report in progress, Draft B	2001-2005
EURAMET.M.M-S2	1054	0.1 mg to 100 g	Mass	NPL	In progress	2008-
EUROMET.M.P-S1	788	0.05 MPa to 1 MPa	Pressure	METAS	Approved and Published	2004-2006
EUROMET.M.P-S2	922	30 Pa to 7 kPa	Pressure	PTB	Approved and Published	2006-2007
EUROMET.M.P-S3	884	80 kPa to 110 kPa	Pressure	LNE	Approved and Published	2006-2008
EUROMET.M.P-S4	861	40 kPa to 1.75 MPa	Pressure	UME	Approved and Published	2005-2006
EURAMET.M.P-S5	931	50 MPa to 500 MPa	Pressure	PTB	Report in progress, Draft B	2007-2008
EURAMET.M.P-S7	1040	0.1 mPa to 1 Pa	Pressure	METAS	In progress	2007-
EURAMET.M.P-S8	1131	-100 kPa to +100 kPa	Pressure	MIKES	Approved and Published	2009-2010
EURAMET.M.P-S9	1170	-950 hPa to 0 hPa	Pressure	LNE	In progress	2011
EURAMET.M.P-S10		0.005 Pa to 100 Pa	Pressure	CEM	In progress	2010
EURAMET.M.T-S1	1055	1 N.m to 1000 N.m	Torque	PTB	Approved and Published	2008-2010
EURAMET.M.T-S2	1141	100 N m	Torque	PTB	Rep. in progress, Draft A	2008-
EURAMET.M.T-S3		10 N.m to 1 kN.m	Torque	CEM	Protocol complete	2010
EURAMET.M.G-S1	1093	g	Gravimetry	METAS	Approved and Published	2008-2009
EURAMET.M.P-S6		1.5 kPa to 300 kPa	Pressure	PTB	Approved and Published	2007-2008
EURAMET.M.F-S1		5 kN to 5 MN	Force	NPL	Approved and Published	2005-2006

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CMCs

11 new submissions or revisions from other RMOs reviewed


5 EURAMET new submissions or revisions approved by JCRB and published


1 EURAMET new submission pending

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Peer Reviews

- Within Project 1123 (TC-Q): CEM, INRiM, IPQ
- UME (on request by Türkak)
- CENAM (Mexico) (January 2010)

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Roadmaps

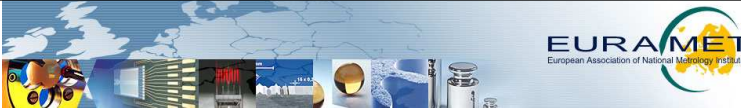
- Roadmaps have been reviewed:
 - No changes for force, pressure and dynamic measurements
 - Mass roadmap slightly updated.
- Freely accessible on the TC website.

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Redefinition of the kilogram - Data

- The International Avogadro Cooperation (IAC) published (end 2010) their final value for N_A



$$u(N_A) \approx 3 \cdot 10^{-8}$$

- Values for h and N_A are now better aligned with those given by the NIST watt balance, but
- there is still a discrepancy of $\approx 1.6 \cdot 10^{-7}$ with the recommended CODATA value

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Redefinition of the kilogram – *Mise en pratique*

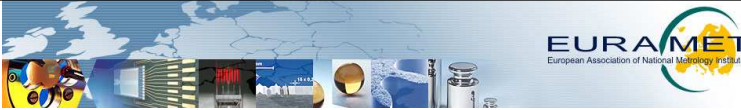
- Practical work on a *mise-en-pratique* is actively underway.
- A CCM comparison (NPL pilot) is ongoing on sorption artefacts. Preliminary results available.
- A *mise en pratique* document is being prepared under the CCM as a joint international effort.

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Redefinition of the kilogram – general framework

- The CCM met twice. In March 2010 a new recommendation was prepared - G1 (2010)



NEEDS

- At least three independent experiments, with $u \leq 5 \cdot 10^{-8}$ (at least one with $u \leq 2 \cdot 10^{-8}$)
- Consistency at the 95 % level of confidence
- Target uncertainty in the realization of the kilogram $\leq 2 \cdot 10^{-8}$
- In May 2011, the WG on Changes to the SI discussed a first draft of *mise en pratique*

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Revision of the SI


- The redefinition of the kilogram is now within the more general revision of the SI
- The CCU met in September 2010. It was acknowledged that a revision in 2011 would be premature
- A recommendation to the CIPM was prepared - U1 (2010), containing the basic scheme of the future SI revision
- Next meetings: CCU, 2012; CCM, 2014 (with possibly a special meeting in 2013)

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EMRP 2010

- Four JRPs under “Industry” (mostly) within the TC-M
 - Traceable Dynamic Measurement of Mechanical Quantities
 - High Pressure Metrology for Industrial Applications
 - Vacuum metrology for production environments
 - Dynamic mechanical properties and long-term deformation behaviour of viscous materials.

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EMRP 2011

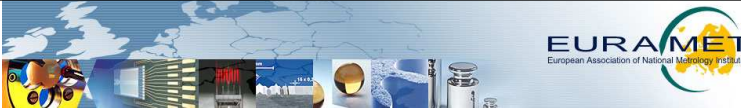
- Call 2011 “SI broader scope”
 - Two Selected Research Topics, SRT:
 - Realisation of the awaited definition of the kilogram - resolving the discrepancies
 - Developing a practical means of disseminating the new kilogram

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Guides on calibration

- Balances: just published. Concerns from some users. Revision considered.
- Force: Published.
- Pressure: Published.

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Issues

- CMC review
 - Discrepancy of approach to review process (and need for KC support) between RMOs.
 - Examples:
 - magnetic properties of mass standards
 - capability of measuring input quantities (such as volume for mass).
- Projects Database
 - Difficulties in obtaining activity reports from coordinators.
- EMRP
 - Largely out of the control of the chairperson.

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The End

Thank you for your attention

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