

16 May 2008

1. General Aspects

The technical committee for electricity and magnetism (TCEM) has three sub-committees (SC) “DC and quantum metrology”, “Low frequency” and “Radiofrequency and microwave”. The SCs deal with scientific and technical issues whereas the more general issues are under the responsibility of the TC. In the period of this report, the main focus of the SCs together with the iMERA working group of the TCEM was the shaping of the joint research proposals submitted in the iMERA-Plus programme.

In its annual meeting the TCEM discussed its organisational structure and the scope of the future activities. The iMERA working group will be transformed into a working group for strategic planning. The group will coordinate the comparison activities within the TC, collect the relevant information on the development of the EM field, revise the road maps for the EMRP on a regular basis and propose long-term plans for future activities. To cope with the new needs for metrology in the power and energy field, the implementation of a new sub-committee “Power & energy” is studied.

2. Projects

Detailed information about the EURAMET projects in the EM field can be obtained from the EURAMET web-site. An overview of the number of projects is given in the table below.

	Comparison	Consultation	Co-operation & research	Traceability	Total
On-going	22 (24)	4 (1)	6 (9)	9 (9)	41 (43)
Completed	58	51	40	2	151
Total	80	55	46	11	192

(Figures in brackets denote the numbers of the previous period)

The number of projects slightly decreased in the reporting period. The number of active comparisons is decreasing and stabilizing on a level which is lower than in the period after the coming into force of the MRA. In the co-operation and research projects a shift towards joint research projects in the framework of the EMRP is about to occur.

3. Comparisons

Presently, 22 (24) (number in brackets: previous period) EURAMET key or supplementary comparisons (8 KCs, 14 SCs) are active in the EM field. The total number of comparisons listed in the key comparison data base sums up to 22 (22) KCs and 26 (26) SCs. Besides this, EURAMET is or has been active in a large number of CCEM comparisons: 9 BIPM KCs, 48 CCEM KCs and 2 CCEM SCs.

To improve the monitoring of the impact of comparison results on the CMC claims, the CCEM revised the Guidelines on Comparisons in 2007. For all running and future comparisons, the impact of the comparison results on the CMC claims will be dealt with in a separate comparison executive report. It is up to the participants to each submit their own part of this report, and not to the pilot laboratory to make a judgement. The report goes to the chair of the relevant TC and to the partici-

pants. It is then the responsibility of the RMO TC chair, or of the RMO review committee, to check the report against the KC results and the CMCs.

In connection with a new supplementary comparison started in 2007, the question has been raised about the participation of laboratories in EURAMET key or supplementary comparisons, which are neither NMIs nor designated institutes. The rules under what circumstances a participation of such laboratories might be possible were not so clear and need to be fixed on the EURAMET level. For the SC in question, it was decided after consultation with the EURAMET chairman to restrict the participation to NMIs and DIs.

4. CMCs

4.1 EURAMET EM CMCs

At its meeting in October 2006, the TCEM decided to start a new round of CMC review. 15 countries submitted revised and new sets of CMCs with in total 643 CMCs and 59 matrices. The Intra RMO Review for this CMC set, named EUROMET.EM.4.2007, started on 9 February and was brought to an end in August 2007. A revised set was then posted on the JCRB web-site for inter RMO review. APMP and SIM carried out the review and posted their report on the JCRB web-site in February 2008. The accepted CMCs were published in the KCDB on 31 March 2008.

In connection with the APMP review, a problem came up which needs to be solved in a more general way. In some cases, APMP reviewers were asking for an extensive documentation covering the CMC entry in question. Usually, these documents are written in the language of the submitting NMI and a costly translation into English would be necessary. In the view of the TCEM, this is an excessive request. As the CMC set of a NMI has to be covered by its quality management system and in addition, the set has already undergone an extensive intra RMO review, the scope of the inter-RMO review should be restricted. General guidelines in this context would be useful to set a reasonable frame for these reviews.

To make the CMC process within the TCEM more efficient, it was decided to introduce a fixed timetable for the submissions and the review. CMs can be submitted on a yearly basis. The deadline for submission is the date of the TCEM meeting in October. A fixed period –usually until the end of the year- will then be allowed for the intra-RMO review. The inter RMO review should be limited e.g. to 3 months.

4.2 Inter-regional review of CMCs

On 17 January 2008, APMP posted the CMC set APMP.EM.6.2008 on the JCRB web-site. The set comprises 460 CMC entries from 8 NMIs. The TCEM will review the set until the end of May 2008.

4.3 Peer review

To respond to the increasing pressure to carry out formalized on-site visits by peers, the TCEM started in 2007 to organise such visits in connection with meetings of the TC. If the institute, hosting a meeting of the TC or a SC, wishes a peer visit, contact persons with the required expertise will carry out a peer review following the JCRB recommendations. The on-site peer review and its scope are reported in form of a EURAMET consultation project. The review outcomes are documented in a separate report open to the reviewed institute and the reviewers. A first on-site peer visit according to this scheme was carried out at the DMDM, Serbia, in connection with the last TCEM meeting.

5. Activities of the Sub-Committees

5.1 Subfield “DC and quantum metrology”

A workshop was hosted by MIKES in Espoo, Finland on 25 to 27 June 2007. There were 65 participants, a majority from EURAMET but also experts from other regional metrology organisations, APMP, SIM and COOMET were present. There were 15 scientific talks and 16 posters, covering the following topics:

- Quantum Hall effect:
A new development is the realisation of the quantum Hall effect in graphene. The physics in such a system is quite different from the physics of heterostructure devices traditionally used in metrology. Precision measurements of the QHR are thus very important in the context of the present discussions about the universality of the QHE.

In the application of the QHE at AC, important progress was made recently. A phenomenological model was proposed which explains the observed frequency dependence of the AC-QHE.
- Single electron tunnelling:
A variety of new types of single charge transport devices are studied. The aim is to improve the accuracy of the charge transport and to increase the current. Quantum current standards play an important role in the closure of the quantum metrological triangle formed by the quantum Hall effect, the Josephson effect and the single electron tunnelling effect. The closure of the triangle would strongly support the exactness of the underlying effects.
- Josephson voltage standards:
Fast progress is made in the development of programmable Josephson standards. The new standards allow the synthesis of arbitrary waveforms with fundamental accuracy, at least in the low frequency domain. The most important applications of this new technology are the ac/dc field and in the measurement of electrical power. On the other hand the development of pulse driven Josephson arrays is pursued. This technique will allow the extension of the frequency into the MHz range.

An international school on “Quantum Metrology and Fundamental Constants” was organised by LNE and METAS in Les Houches, France, from 1 to 12 October 2007. The school gathered 83 participants from 20 countries. One third of the participants came from the academic area, the two other thirds came from NMIs. The program included 33 lectures and two poster sessions during which the students presented their work. A debate closed the school by going back to the key questions presented at the beginning of the school. The detailed program, slides of the lectures and posters are available at: <http://www.metas.ch/LesHouches>.

5.2 Subfield “Low frequency”

The LF experts meeting on ac-dc transfer took place in Espoo, Finland, on 27 to 29 June 2007. For the first time both the DC & Quantum meeting and the LF meeting were coordinated in time and place (see above). Some 60 participants took part in the LF meeting. The meeting started with a common day for both meetings on Quantum based ac voltage standards. The following topics were discussed:

- The development of ac voltage standards based on the Josephson effect has now reached a state where they can start to be used as primary standards. One can foresee that the next key comparison on ac-dc voltage transfer at the primary level will be very interesting as both thermal voltage converters and quantum based standards will be used by different NMIs.
- A memorial talk on Frank Hermach and his outstanding contributions to the field of ac-dc transfer was given. Frank Hermach introduced the thermal converters as a precision instrument for

ac-measurements. Also Jan de Vreede was remembered for his long engagement in electrical metrology and as the chairman of five ac-dc experts meetings from 1992 to 1997.

- During the meeting some ten oral and twelve poster presentations were given, ranging from quantum ac voltage standards and ac-dc current transfer to power quality measurements. In a round table discussion the availability of thermal converters was discussed. The CCEM made a statement on this in 2006. The availability of both multijunction and single junction thermal converters is a serious problem, which can be even worse in the future. Quantum based ac standards will be used as primary standards in the future but most NMIs will depend on thermal converters as working standards.
- Updates were given by SP on the key comparisons CCEM-K11 and the regional KC EU-ROMET.EM-K11 on ac-dc voltage transfer difference at low voltages. The report on CCEM-K11 has been approved by the CCEM and is published in the KCDB. NMIA informed on the key comparisons CCEM-K12 on current ac-dc transfer standards.
- An update on the EMRP and ERANET+ was given and possible JRPs were discussed.

5.3 Subfield “Radiofrequency and microwave”

The last meeting was held at NMi VSL on 26 & 27 April 2007. Participants came from 14 countries and a new format of 1.5 days plus laboratory tour was employed. There were three half day sessions on administration, technical matters and ERANET+ / EMRP.

There were 9 talks in the technical session covering a range of RF topics with the emphasis on areas which could be the basis of collaboration in anticipation of the call for expression of interest under iMERA-Plus.

6. Participation in iMERA-Plus

The TCEM community was involved in ten JRP proposals (8 TP 4 and 2 TP 1), of which 7 were selected for funding in the iMERA-Plus frame. The list of projects is given in the table below.

The TCEM and its subfields were discussing possible joint research projects (JRP) intensively in spring 2007. This preparatory phase was very important. It allowed later on to cope with the tight deadlines set for the submission of EOIs and the JRP proposals.

Nmb.	JRP ref.	Short name	Title	Rank
<i>funded projects</i>				
1	T1.J1.1	e-MASS	Watt balance	2
2	T1.J1.3	REUNIAM	Redefinition of the SI base unit ampere	3
3	T4.J01	Power & Energy	Next generation of power and energy measuring techniques	7
4	T4.J03	JOSY	Next generation of quantum voltage systems for wide range applications	10
5	T4.J07	EMF and SAR	Traceable measurement of field strength and SAR for the Physical Agents Directive	13
6	T4.J04	ULQHE	Development of ultimate metrological QHE devices	18
7	T4.J02	NanoSpin	Nanomagnetism and Spintronics	21
<i>not funded</i>				
8	T4.J05	Microwave & Terahertz	Future microwave and terahertz metrology	24
9	T4.J06	LF-RF gap	Bridging the LF-RF Gap in Electrical Metrology	28
10	T4.J08	Comm-Met	Metrology for wireless communications	37

7. Meetings

The annual meeting of the TCEM was held in Belgrade on 18 and 19 October 2007. The meeting was hosted by the Serbian Directorate of Measures and Precious Metals (DMDM). It was attended by 34 delegates representing 26 EURAMET members, three associate members (Albania, Bosnia-Herzegovina and Montenegro) and the BIPM. The main topics of the agenda were:

- Reports on new developments within EURAMET, the CCEM and its working groups, the BIPM electricity section and the activities of the three TCEM subfields
- Report on the status of the EMRP and the proposed joint research projects under the ERA-NET-Plus scheme
- Review of ongoing and new projects
- Discussion on the future activities of the TCEM and the organisation of the subfields
- Report on the status of the CMC set EUROMET.EM.4.2007 and discussion on the CMC procedures and the next CMC review
- Technical talks on: the high ohmic comparison EUROMET.EM-K2, an evaluation study of self-adjustment routines for the calibration of LCR meters and about the work of Nikola Tesla.

8. Strategic planning

As mentioned in Sect. 1, the iMERA WG will be transformed into a WG on strategic planning. The group should:

- propose new comparisons and coordinate the comparison activities within the TC
- collect the relevant information about the development in the EM field

- develop and revise the roadmaps for the EMRP including changing the scope as required
- propose long-term plans for the future activities of the TCEM.

The terms of reference of this group will be fixed at the next TCEM meeting in 2008.

9. Outlook for 2008/2009

9.1 Special activities

- Decision on the SC structure within the TCEM and on the terms of reference of the different groups.
- Introduction of fixed time frames for the review of CMC sets
- Mapping of the traceability routes within EURAMET in the EM field.

9.2 Meetings

- TCEM: 16 to 17 October 2008, Dublin, hosted by NML Ireland
- Working group on strategic planning: 15 October 2008, Dublin, Ireland
- DC /Quantum Metrology subfield:
 - 7 June 2008, satellite meeting CPEM 2008, Broomfield, CO, USA
 - spring 2009, LNE, Paris
- LF subfield:
 - 8 June 2008, satellite meeting CPEM 2008, Broomfield, CO, USA
 - spring 2009, LNE, Paris
- RF and microwave subfield:
 - spring 2009, SP, Boras, Sweden

Wabern 16 May 2008

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