EUROMET Technical Committee for Electricity and Magnetism (TCEM)
Chairman's Annual Report for 2005/2006

1. Introduction

The work within the TCEM is organised as follows: More general issues are under the responsibility of the Technical Committee, whereas technical issues are dealt with in the three sub-fields "DC and quantum metrology", "Low frequency" and "Radiofrequency and microwave". At its meeting in October 2005 at METAS, the TCEM installed a iMERA Working Group which is responsible for drawing up the TCEM roadmaps for the EMRP and for future iMERA and Art. 169 activities.

CMC's and comparisons dominated the work of the TCEM in the past. This changed already in the period under review in favour of a closer co-operation in research, because the TCEM is strongly involved in the iMERA project. The number of ongoing comparison projects is still high, it will however decrease in the near future, because many comparisons are now at a Draft A or Draft B stage. This will enable the TECM to strengthen its future activities more on scientific issues.

2. Meetings

The **TCEM** met on October 13 and 14, 2005 at METAS in Bern, Switzerland. Main topics of the agenda were

- reports on new developments within EUROMET and other regions, the CCEM and its working groups, and the activities of the TCEM sub-fields
- a review of ongoing and new projects
- technical talks on the impact of the Watt balances of METAS and LNE on a possible redefinition of the kg and a new quantum capacitance standard based on SET
- future activities of the TCEM in the iMERA project
- installation of a iMERA Working Group

The iMERA project occupied a large part of the discussion. The contact persons of the TCEM observe the development with great interest, the more as they believe, that the iMERA project could provide a good opportunity to strengthen the position of scientific metrology in Europe.

The **iMERA Working Group** held its first informal meeting on 12 October at METAS in Bern, Switzerland. An introduction to the iMERA Project and up-date on ongoing iMERA activities, a discussion on the terms of reference for the iMERA Working Group, the next steps to be taken and the iMERA meeting for briefing TC chairs were topics on the agenda. The participants were unanimously in favour of installing such a working group and decided to ask the TCEM contact persons for approval.

Following these two meetings, a **iMERA meeting for briefing TC chairs** was organised on 19 October 2005 by MIRS in Ljubljana, Slovenia. This meeting aimed to inform the TC's about new developments of the iMERA project and to train them for the coming roadmapping process. The TCEM was represented by 5 people.

The meeting **of the sub-field "DC and quantum metrology"** was held at METAS in Bern, Switzerland in May 2005. 8 techncial talks, 2 invited talks, satellite meetings, a poster session and a workshop on impedance measurements such as capacitance in R_k, and AC QHR were on the agenda of the meeting. Activity has been maintained in single charge transport with several possible routes for closing the triangle. A workshop on low and high DC current has been proposed for the next meeting at MIKES in 2007.

The **sub-field "Low frequency"** met at CEM in Madrid, Spain in May 2005. The meeting had 34 participants representing 30 NMI's from many regions including APMP, SIM and COOMET. The meeting concentrated on AC/DC transfer and reviewed LF projects. These are mainly comparisons. Information was discussed on CCEM-K12 – ac/dc transfer on current to 100kHz - and on CCEM-K11 – ac/dc transfer on low voltages. Technical highlights were presented by NMI's. A questionnaire will be sent to participants on what resources they can make available to other NMI's. Discussion at this meeting suggested a power meeting is urgently needed. The next meeting in 2007 will be held at MIKES, during the same week and just after the DC and quantum metrology meeting.

13 NMI's were represented at the meeting on the **sub-field "Radiofrequency and microwave"** in April 2005 at METAS in Bern, Switzerland. Some detailed technical reports and reports on comparisons were discussed. There is still an issue of the number of data points needed for a useful RF comparison and a graph was shown on loss of information when only the information published in the annex data for the database is considered. The meeting had suggested change for the classification scheme for power quantities away from calibration factor. The issue is when should such a change be made. The implications of changing the scheme are far-reaching and the WG RMO should discuss this. There will be an ad hoc meeting in CPEM 2006 and the next full meeting will be in spring 2007 at NMi-VSL.

There was a discussion on where **magnetics** is covered within the sub-field scheme. It may be necessary to change the scope of the LF group, although nanomagnetics and spintronics may be covered in the DC and quantum metrology group. Informal meetings of the sub-fields will be held on occasion of the CPEM 2006 in Torino, Italy.

3. Projects

Detailed overview of the EUROMET Projects in the field of Electricity and Magnetism can be obtained from the EUROMET website. The table below gives only a brief overview of ongoing and completed projects.

	Comparison	**Co-operation**	**Traceability**	**Consultation**	**Total**
Ongoing	31 (31)	8 (7)	9 (8)	2 (7)	50 (53)
Completed	47	36	2	46	131
Total	78	44	11	48	181

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

In the period under review, the number of ongoing projects could be nearly maintained. With about 60 % of the total number of projects, comparisons are still dominating. The large

number of comparison projects reflects the EUROMET, CCEM and BIPM comparison activities in the fields of DC&LF and RF. Beyond that, the number of traceability projects has increased by one, from 8 to 9. In the future, it is intended to increase the number of projects for co-operation in research as well.

4. Comparisons

Presently, 25 (22) EUROMET key or supplementary comparisons (12 KC's, 13 SC's) are active in the field of Electricity and Magnetism. The total number of comparisons sums up to 22 (17) KC's and 25 (19) SC's (Figures in brackets denote the numbers of the previous period). Besides this, the TCEM is or has been involved in a large number of BIPM and CCEM comparisons: 9 BIPM KC's, 45 CCEM KC's and 2 CCEM SC's.

There is a certain tendency to bilateral comparisons, because this type of comparison puts a lower workload on the pilot laboratories and at the same time can be completed in a much shorter time. As this tendency is unfavourable for the whole system, this point has been addressed at the last TCEM meeting, and laboratories were asked to avoid bilateral comparisons, if possible. An alternative could be to share the tasks for a comparison: A first trial was made with EUROMET Project 816 – an inductance comparison at the 100 mH level. INM, Romania acts as the pilot laboratory, PTB supplies the standards and NMi-VSL writes the report.

5. Status of EUROMET EM CMC's

The TCEM asked for Inter RMO Review of its 3rd CMC round (6 countries submitting their first set of CMC's, EUROMET.EM.2.2005) in January last year. Regardless the Internet-based procedure, this review lasted for more than one year and was finally completed in March 2006. This is by far too long and can not be tolerated by the submitting laboratories, the more, as this caused a delay of our 4th round by about one year.

Immediately after the TCEM meeting in October 2004, the TCEM started an Intra RMO Review for the 4th round with 10 countries submitting new and revised CMC's. The Intra RMO Review was completed at the end of January 2005 but the CMC's were not submitted for Inter RMO Review, because the Inter RMO Review for the 3rd round (EUROMET.EM.2.2005) was still going on. As soon as the 3rd round came to an end, round 4 was posted on the JCRB web-site in January this year (EUROMET.EM.3.2006).

Reasons for the delay were different opinions among the RMOs with regard to the QS and comparisons. The TCEM chairperson addressed this point to the JCRB Secretary to find a solution which solves this problem. The answer of the JCRB is unambiguous: Any time that a new CMC is submitted or a CMC is amended, the RMO has to reaffirm the status of the quality system supporting the new or modified claims. This is germane as quality systems are living documents, which in some cases can loose accreditation due to deficiencies. In future, the TCEM will ask the submitting NMIs to reaffirm their QS and will include these affirmations in the intra-regional review report accompanying the claims. Concerning the comparisons, Document *JCRB-14/06(2a)_final* clearly states that key comparisons are not an indispensable requirement for the acceptance of CMC's into Appendix C of the CIPM-MRA. Key comparisons are the preferred way to support a CMC claim, but it is commonly

regarded that it would be impractical for all CMC's to be supported by key comparisons. As long as CMC's meet the criteria stated in Document *JCRB-14/06(2a)_final*, the inter-regional review cannot exclude them from the Appendix C of the CIPM-MRA.

6. Status of inter-regional review of CMC's

In October 2005, APMP asked for Inter RMO Review of their CMC set APMP.EM.5.2005. The TCEM agreed to do the Inter RMO Review with a due date end of January 2006. There was a delay due to the fact, that the discussions between the reviewers and the submitting laboratories took more time and that APMP did not submit the latest CMC table for one of the laboratories. The Inter RMO Review has been completed by the end of March with a report and the revised CMC's sent to JCRB.

In March 2006, SIM asked for the Inter RMO Review of their CMC set SIM.EM.1.2006 with in total 218 CMC's from Brazil, Panama and the United States. The TCEM agreed to do the Inter RMO Review with a due date end of August 2006.

7. The iMERA Project

To cope with the requirements of the iMERA project, the TCEM formed an iMERA Working Group, the TCEM chair, co-chair and past chair as well as the present and past convenors of the Sub Groups being members of this WG. Altogether they form a fair representation of large, medium-size and smaller NMI's of EUROMET.

The Terms of Reference of the group are as follows:
- To develop and up date a research programme for Electricity and Magnetism
- To indicate research activities of interdisciplinary nature within Electricity and Magnetism and to co-ordinate these activities with other TC's
- To develop roadmaps for already existing areas of activity
- To identify new areas of research in Electricity and Magnetism
- To review and up date lists of special facilities in Electricity and Magnetism
- To encourage the installation of Joint Research Projects
- To discuss possible new structures of the TCEM

The iMERA WG has been strongly involved in the roadmapping process to draw up the EMRP in the field of Electricity and Magnetism. It defined the following fields of activity for which roadmaps have been developed:

- Power and Energy
- Electronic Characterisation of Nanostructures
- Electrical Quantum Standards
- RF and Microwave Measurements
- Information and Communication Technology

Together with the roadmaps three to four pages of explaining text have been uploaded at the iMERA web portal.

Three members of the TCEM (LNE, NPL and PTB) are engaged in a Quick Start Project *"Study of a real-time control unit for JDAC arrays: application to Watt balance experiments"* under iMERA workpackage 4.4. This project aims at gaining experience with a centrally funded research project and to test the practical aspects of managing such projects.

In addition, the TCEM started a Joint Research Project to develop a *"Binary Josephson Array Power Standard"*. The emphasis of this project will be to provide experience and a case study in managing collaborative research and development. The project is funded by co-ordinating resources from the national programmes of the participating laboratories. Seven European NMI's (LNE, METAS, MIKES, NMi-VSL, NPL, PTB, SP) which are all iMERA partners together with NIST, US and VNIIM, Russia are involved in this activity, with PTB acting as the pilot institute. Six work packages have been defined which cover the electronics, array fabrication, verification of waveforms, sampling and synchronisation methods, combination of a Josephson array with a power standard and comparisons, and which are each lead by one of the participating institutes. The kick-off meeting was held on 23-24 February 2006 at PTB. The project started on 1 April 2006 with a duration of three years.

The CCEM established an ad-hoc Working Group on Strategic Planning (WGSP) which met on 2 October 2005. Much of the discussion concerned the issues of identifying the challenges to metrology in electricity and magnetism, learning which NMI's are addressing these challenges, exploring possibilities of co-operative efforts in research and development activities and planning the long-term activities of the CCEM to help meet the challenges. The group decided to prepare a questionnaire to be sent to all CCEM members. The purpose of the questionnaire is to: identify current areas of activity, provide a basis to identify potential opportunities for international collaboration, assist NMI's to decide the future areas of activity they need to be considering, serve as a guide to the activities and priorities of the CCEM and assist the CCEM in deciding on appropriate future directions of work to recommend for BIPM. The TCEM on the one hand contributed considerably to this questionnaire and on the other hand draw benefit from it with respect to its roadmapping activities.

Hans Bachmair — Braunschweig, 21 April 2006

Technical Committee Chairman for
Electricity and Magnetism