APPENDIX E 3.
REPORT OF THE 22ND MEETING OF THE
CCEM WORKING GROUP ON RADIOFREQUENCY QUANTITIES (GT-RF)
(13 MARCH 2013)
TO THE CONSULTATIVE COMMITTEE FOR ELECTRICITY AND MAGNETISM

List of Members of the CCEM Working Group on Radiofrequency Quantities (GT-RF) as of 13 March 2013.

Chairman

Dr Jim Randa, National Institute of Standards and Technology [NIST], Gaithersburg

Members

Agency for Science, Technology and Research [A*STAR], Singapore

Federal Institute of Metrology [METAS], Bern-Wabern

Institute for Physical-Technical and Radiotechnical Measurements, Rostekhregulirovaniye of Russia [VNIIFTRI], Moscow

International Bureau of Weights and Measures [BIPM], Sèvres

International Union of Radio Sciences [URSI]

Istituto Nazionale di Ricerca Metrologica [INRIM], Turin

Korea Research Institute of Standards and Science [KRISS], Daejeon

Laboratoire national de métrologie et d'essais [LNE], Paris

National Institute of Metrology [NIM], Beijing

National Institute of Standards and Technology [NIST], Gaithersburg

National Measurement Institute, Australia [NMIA], Lindfield

National Metrology Institute of Japan [NMIJ/AIST], Tsukuba

National Metrology Institute of South Africa [NMISA] Pretoria

National Physical Laboratory [NPL], Teddington

National Research Council of Canada [NRC-INMS], Ottawa

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig

VSL [VSL], Delft

Mr Luc Erard [former chairman of GT-RF, member of the CIPM]

The meeting took place on Wednesday, 13 March 2013, in the Pavillon du Mail at the BIPM, Sèvres.

The meeting was chaired by Dr Jim Randa (NIST).

The following delegates were present: Mr Edson Afonso (INMETRO), Dr Djamel Allal (LNE), Dr Luciano Brunetti (INRIM), Dr Mustafa Cetintas (UME), Dr Laurie Christian (MSL), Dr Sze Wey Chua (A*STAR), Mr Luc Erard (CIPM member), Dr Israel Garcia-Ruiz (CENAM), Dr Gleb B. Gubler (VNIIM), Dr Barry Inglis (NMIA, CIPM), Dr Rolf Judaschke (PTB), Dr Nobu-Hisa Kaneko (NMIJ/AIST), Dr No-Weon Kang (KRISS), Dr Alexander S. Katkov (VNIIM), Dr Sergey Kolotygin (VNIIFTRI), Dr Sergey Korostin (VNIIFTRI), Dr Gregory Kyriazis (INMETRO), Dr Héctor Laiz (INTI), Mr Alexander Matlejoane (NMISA), Dr Po Gyu Park (KRISS), Dr François Piquemal (LNE), Dr Gao Qiulai (NIM), Dr James Randa (Chairman, NIST), Dr Gert Rietveld (VSL), Dr Yoho Shimada (NMIJ/AIST), Dr Michael Stock (BIPM), Dr Perry Wilson (NIST), Dr Markus Zeier (METAS).

1. Preliminaries

The Chairman, Dr Randa, opened the meeting at 09:10. The attendees were asked to introduce themselves. Dr Judaschke was appointed rapporteur of the meeting. The agenda was outlined and approved.

2. Developments since the 21st meeting

Dr Randa summarized the developments since the last official meeting:

- The report on the 21st meeting (2011) of the GT-RF has been approved and is available on the BIPM website.
- Two new CMC categories had been approved: “Flatness of RF voltage sources” and “Flatness of RF voltage meters”.
- The RMO comparison APMP.EM.RF-K8.CL (power in 50 Ω coaxial lines) with NMIJ as pilot has been revived; the technical protocol and declaration form have been approved by the GT-RF.
- CEM (Spain) and INTI (Argentina) are new members of the CCEM. CENAM (Mexico) was granted observer status.
- GT-RF and WGLF have now the opportunity to review RMO supplementary comparison (SC) reports.
- Forthcoming CPEM conferences will take place in Rio de Janeiro (2014), Ottawa (2016), and Paris (2018).
- The bilateral comparison APMP.EM.RF-K3.F (participants NMIJ and KRISS, pilot) on antenna gain, frequency range 26.5 - 40 GHz, was completed and approved for equivalence in the KCDB.
- The comparison APMP.EM.RF-S3 on reflection coefficient (50 MHz – 18 GHz), pilot NPLI, was approved and published.

3. Comparisons in progress

3.1 CCEM.RF-K5.c.CL (S-parameters, PC3.5, 100 MHz to 33 GHz, pilot NMIJ)

NMIJ and METAS (linking lab) have finished the measurements, the NIST (linking laboratory) is now measuring the comparison artefacts. A delay of approximately two months from the original schedule has arisen due to relocation of a laboratory at the NIST.

3.2 CCEM.RF-K22.W (Noise, 18 – 26.5 GHz, pilot LNE)

The Draft A report is slightly delayed and will be finished by end of May 2013.

3.3 CCEM.RF-K23.F (Antenna gain, 12.4 – 18 GHz, pilot NIST)

The horn antennas are back at the NIST having been circulated to the participating laboratories. The final measurements at the NIST will be completed in due course. The work on the Draft A report will begin in the near future and finish in early April 2013.

3.4 CCEM.RF-K24.F (Field Strength, 1 – 18 GHz, pilot NPL)

The Draft B report was circulated to the participants in late 2012, and the final version (356pp) was submitted to the GT-RF Chairman on 9 January 2013. Dr Zeier asked if any follow-up action, especially with regard to changes of CMC entries will be initiated due to the poor degrees of equivalence for one of the artefacts (diode sensor). This was negated by J. Randa who offered a delay of approval which was, however, refused by Dr Zeier. The Draft B report will be circulated to the CCEM for approval.

3.5 CCEM.RF-K25.W (Power, 33 – 50 GHz, pilot PTB)

The second measurement loop ended in February 2013. Currently the PTB performs the final measurement. The Draft A report will be finished in June 2013.

3.6 Pilot study (EM properties of materials, pilot NIST)

The responsibility for the study has been undertaken by Dr Janezic (NIST) after the original pilot, Dr Baker-Jarvis passed away. Dr Wilson referenced working document CCEM GT-RF/13-15 which summarizes the current study status. After calling for participation in 2012, nine NMIs have expressed an interest to participate. The proposed sample geometries for the pilot study are rectangular substrates and toroids. A draft of the measurement protocol will be circulated to the NMIs in June 2013.

3.7 APMP.EM.RF-K8.CL (Power, type N, 10 MHz – 18 GHz, pilot NMIJ)

The travelling standards (two power sensors, power meter included) are currently on the first measurement loop with the schedule on time. The first loop will be finished in March 2013.

3.8 SIM.EM.RF-K5.b.CL (S-parameters, type N, 2 GHz – 18 GHz, pilot INTI)

The protocol has been published in the KCDB. The measurement loop started in October 2012. Currently, the schedule is on time, i.e., the final measurement is expected to be performed in April 2013.

4. Possible new key comparisons

The NMIJ proposes a new comparison on attenuation. The corresponding working document CCEM GT-RF/13-18 was presented. Two step attenuators (0 dB to 90 dB and 0 dB to 60 dB) will serve as travelling standards. Following the discussion at the previous meeting in 2012, the connector will be PC2.4 rather than PC2.92. Twelve NMIs have expressed an interest in participating: A*STAR, INTI, KRISS, LNE, METAS, NMIA, NMIJ, NIM, NIST, PTB, VNIIFTRI and VSL. As members of the support group, NIM volunteered, furthermore A*STAR, METAS and LNE tentatively. A. Widarta is the contact person at the NMIJ.

Interest in additional new comparisons, especially on RF voltage, was not ascertained by the Chairman. Furthermore, there are currently no proposals for new RMO comparisons.

5. CCEM strategic plan

To give some background information about the recent CCEM activity to setup a strategic plan for the next decade (document “CCEM Strategic Plan”, CCEM/GT-RF/13-04), Dr Randa summed up the background document “Request for a CCEM strategic plan”, CCEM/13-05, by Dr Stock, which cites a concept for the elaboration of the future CC work programmes.

As a result of the discussion on the corresponding template CCEM GTRF/12-04 during the informal GT-RF meeting at the CPEM 2012 and based on the input from the NMI representatives after this meeting, Dr Randa has worked out the GT-RF plan for the next decade. This plan was circulated among the NMI representatives in 2012 and finally merged with the WGLF contribution to the CCEM Strategic Plan. (Working document CCEM GT-RF/13-04).

Dr Randa presented the current version of the CCEM Strategic Plan with special focus on section 9, “Summary table of comparisons, dates…”. This was followed by a longer discussion about a potential improvement of this document.

Dr B. Inglis commented that the Strategic Plan should not entirely focus on key quantities and directly related activities such as key comparisons, but also on a much broader scope, especially on emerging technology and their challenges.

Dr Piquemal suggested the addition of information about RMO comparisons in section 1 (“General Information on CC body”), since they support CMC entries. Furthermore, electrical nano-metrology could become important and should be mentioned.

Dr Stock remarked that a broader scope with respect to future planning is already addressed by the CCEM document “Big Problems in Electromagnetics”, published on the CCEM website. Reference to this document should be considered.

Dr Rietveld suggested that key comparisons should be repeated from time to time due to changes in expertise following staff changes within the NMIs. Dr Randa stated that a repetition of comparisons is not explicitly excluded in the document. Dr Judaschke remarked that a repetition of comparisons is reasonable, but seems to be unrealistic because of the continuous extension of the frequency range to be covered.

Dr Cetintas noticed that the inclusion of increasing scales (e.g. large field strengths) is important for industry and stakeholders. This should be addressed.

Dr Zeier asked for the update procedure for the Strategic Plan in the future. Dr B. Inglis answered that an update should be synchronized with the BIPM work programme cycle, i.e. two years prior to the next General Conference.

6. Proposal for change of CMC entries

Dr Piquemal presented a proposal on the re-organization of CMC entries which is considered within EURAMET. Currently, the number of CMC entries amounts 7091 (+ 37 and +131 matrices within EURAMET and APMP, respectively) and is continuously increasing due to the large spectrum of quantities, instruments and artefacts. This could result in 10 000 entries in due course.

The proposal will result in a new format of CMC tables with a significantly reduced number of entry lines and enriched matrices. Thus, the number of CMC lines will be reduced to one single CMC line for each subcategory by the use of matrices.

The NMIJ remarked that the use of matrices is reasonable, however, single entries should remain accessible in the database. Dr B. Inglis added that database access should give a good overview especially to end users.

Dr Stock pointed out that the existing KCDB is compatible with matrix formulation for each sub-sub-category, but not with the EURAMET proposal.

The GT-RF delegates decided to recommend that the policy of using matrices for sub-sub-categories in CMC entries should not just be encouraged, but enforced. A two-year grace period would be allowed, to give NMIs the time to change their entries.

The EURAMET proposal should be retained for discussions on development of a future version of the KCDB.

7. Presentation of waveform metrology

Due to the absence of Mr Hale, this agenda point was cancelled.

8. Other business

8.1 Suggestions for controlling the length of final reports

Dr Randa presented suggestions to reduce the length of KC final reports (see document GT-RF/13-14). Since there is common agreement that the number of participants should not be limited unless it is absolutely necessary, the following strategies could be considered:

- Only the results of one (primary) artefact are included in the report. Results from the secondary artefact are only used if the primary artefact fails.
- Limit the number of frequency points to three. Other points could be evaluated in a supplementary report.
- Include only three or four uncertainty budgets from each NMI.
- Limit the number of other parameters to three (high – middle – low).

The presentation was followed by a discussion of different aspects without any decision on an official recommendation on the matter. Dr Zeier mentioned that while it is useful to collect data with the full frequency response for a better understanding of issues and problems, one could consider producing summary statements, e.g. average degrees of equivalence, for the official report (see document GT-RF/11-13).

8.2 Terms of reference of the GT-RF

Dr Randa presented the proposed version of the "Terms of reference of the GT-RF". With only two changes to the wording, it was approved by the delegates and will be sent as a recommendation to the CCEM.

9. GT-RF membership, new GT-RF chairman

The following organizations/persons are members of GT-RF:

BIPM, INRIM, KRISS, LNE, METAS, NIM, NIST, NMIA, NMIJ, NMISA, NMC-A*STAR, NPL, NRC, PTB, URSI, VNIIFTRI, VSL, M. Luc Érard.

Dr Randa proposed Dr Zeier (METAS) as new GT-RF Chairman which was agreed unanimously by the delegates. Dr Randa will forward the suggestion to the CCEM.

10. Developments at the NMIs

The NIST and the CENAM gave presentations on recent developments in their laboratories, see GT-RF working documents. The METAS has submitted a report on its developments which is available on the GT-RF website.

11. Bilateral degrees of equivalence

Dr Stock proposed that the matrix of bilateral degrees of equivalence for all comparisons are no longer calculated systematically. The main information on the results of a comparison and on the equivalence of the participants is contained in the unilateral degrees of equivalence and the related

graphs. This proposal was received favourably. It was recommended that full information allowing calculation of bilateral degrees of equivalence should be provided. This particularly includes significant correlations between participants' results, if they exist. This topic should be discussed further in the CCEM meeting.

12. Decision on public documents

It was decided that no working documents from this meeting should be made public on the open access section of the GT-RF website.

13. Next meeting

The next informal meeting will be held during the CPEM 2014 in Rio de Janeiro, Brazil. Due to the cost of accommodation, it was suggested to hold the meeting during the conference.

The next formal meeting of the GT-RF will be held during the next CCEM meeting, which is expected to take place at the BIPM in March 2015.

The meeting was closed at 13:00.