Minutes of CCT-WG5 meeting

Chair: Graham Machin, NPL
Date of report: 06 May 2010, 8:30 – 13:00
Location: BIPM, Sevres, Paris, France

Attendees

Attending members

A*STAR (Wang Li), CEM (Maria Jose Martin Hernandez, new), INRIM (Ferruccio Girard [replacing Mauro Battuello]), LNE-INM/Cnam (Mohamed Sadli), NIM (Zundong Yuan), NIST (Howard Yoon), NMIA (Mark Ballico), NPL (Graham Machin, chair), PTB (Joerg Hollandt), SMU (Peter Nemecek), UME (Ahmet Diril), VNIIM (Mikhail Matveyev)
CCPR official representative (Nigel Fox), President CCT (Huseyin Ugur), Secretary designate CCT (Alain Picard), WG8 chair, part of meeting (Greg Strouse)

Attending co-opted members

NIM, formerly NMIJ and VSL, (Pieter Bloembergen), NMIJ (Yoshiro Yamada), PTB (Juergen Hartmann)

Observers

CENAM (Edgar Mendez-Lango (for Daniel Cardenas-Garcia)), INMETRO (Renato Teixeira), KRISS (Inseok Yang for Chul Woung Park), NIST (Leonard Hanssen), NRC (Ken Hill), SMU (Roman Dubnicka)

Apologies

CENAM (Daniel Cardenas-Garcia [M]), KRISS (Chul Woung Park [M]), MSL (Peter Saunders [M]), NIM (Tiejun Wang [C]), NMIJ (Juntaro Ishii [M]), NPL (Emma Woolliams, for MeP-K HT Task Group [C]), VNIIOFI (Boris Khlevnoy [C]), VSL (Eric van der Ham [M])

{[M] = member, [C] = co-opted}

Introduction

CCT-WG5 met on 06 May 2010, 8:30 – 13:00, at the BIPM. The agenda for the meeting is given in Appendix I of these minutes. It was modified slightly during the meeting to advance the discussion concerning key comparisons. These minutes reflect the new agenda order, they are also the action record of the meeting. Actions are listed in Appendix II.

Membership

The meeting opened with each attendee introducing themselves and, where appropriate, giving a few words about their institute.

New members welcomed were; CEM (Maria Jose Martin Hernandez) and CENAM (Daniel Cardenas-Garcia). Due to other commitments Mauro Battuello of INRIM stood down from WG5, his place is taken by Ferruccio Girard. Juergen Hartmann (PTB) is changing role at PTB and his co-opted place will be taken by Klaus Anhalt. Both Mauro and Juergen are warmly thanked for their strong contribution to the work of WG5. Other attendees are listed at the beginning of these minutes.

Discussion of potential radiation thermometry key comparison (KC)
This item was advanced in the agenda to allow Greg Strouse (chair WG8) to participate. It is clear that there are currently no KC to substantiate the current or proposed cmc entries in radiation thermometry. A proposal was to be made to undertake a KC below the silver point. MB advanced the view that any KC should only test primary realisations of the ITS-90, this view was accepted by WG5. This means that where the ITS-90 is realised by contact thermometry, i.e. below the silver point, KCs of platinum resistance thermometers (PRTs) were the only appropriate ones to be undertaken, not radiation thermometry. However it is clear, because of the complicating issues (such as emissivity, furnace gradients and wavelength of instrument) surrounding the linkage between contact thermometry and radiation thermometry that some form of comparison is necessary. In this situation RMOs have the responsibility to run supplementary comparisons to support their calibration services, these should be run under the same conditions as a KC with the protocol being scrutinised by WG7 (key comparisons).

It was felt that a KC should be held for the ITS-90 (and where realised *T*) above the silver point. Timescales and initiating this should be seriously considered at the next CCT, one proposal was the use of doped high temperature fixed points as transfer artefacts, as being the only realistic means of probing a primary realisation of the ITS-90 above the Ag point. Chair of WG8 left at end of KC discussion.

Action01: GM to inform chair of Euramet TCT that a regional comparison of radiation thermometry below the silver point should be initiated to support services offered and claimed cmc entries.
Action02: GM to include on agenda for next CCT-WG5 meeting at CCT (May 2012) proposals for KC above the silver point

Review of minutes and action record of last meeting
The minutes of the last formal meeting of WG5 held on 21st May 2008, were reviewed and agreed. All actions had been completed and were signed off.

Review of terms of reference and tasks
The terms of reference and task list were discussed. These were slightly edited to improve the English. It was felt that a new task concerning key comparisons should be added and the task "recommending key comparisons relevant to WG5 to CCT" was duly added to those of WG5 at the plenary session of CCT.

The agreed terms of reference and task list of WG5 now stands as:

Terms of reference of WG5 are to study and advise the CCT on issues related to thermal radiation methods for temperature measurement and to develop and maintain an effective liaison with the Consultative Committee for Photometry and Radiometry.

Working Group 5 is tasked with:
•evaluating thermodynamic measurement results at higher temperatures;
•examining and coordinating activities related to high-temperature fixed points;
•providing appropriate input into the *mise en pratique* for the definition of the kelvin;
•providing updates for the *Supplementary Information for the ITS-90*, as required;
•providing definitive guidance on secondary non-contact thermometry methods, as required;

•supporting world efforts in radiation thermometer and thermal imaging standardization;
•generating appropriate uncertainty budgets for radiation thermometry
•recommending key comparisons relevant to WG5 to CCT

Action03: GM to recommend to CCT additional task for WG5 concerning key comparisons

The mise-en-pratique for the kelvin at high temperatures
CCT24 instructed WG5 to prepare for the *MeP*-K "a new section on primary radiation thermometry, discussing both primary thermometry by absolute radiometry, and approximations to primary thermometry by use of high-temperature eutectic fixed points in conjunction with appropriate interpolation equations". A Task Group within WG5 was established to undertake this activity; the members of this group were; Peter Saunders (MSL), Pieter Bloembergen (NIM/NMIJ), Howard Yoon (NIST), Yoshiro Yamada (NMIJ), Graham Machin (NPL, chair), Emma Woolliams (NPL), Juergen Hartmann (PTB).

Three documents were produced by this group; a background document on primary radiometry, CCT/10-12 "Realisation and dissemination of thermodynamic temperature above the silver point (1234.93 K)"; CCT/10-13 "*MeP*-K direct methods: Absolute (spectral-band) radiometry (radiation thermometry)" and CCT/10-14 "*MeP*-K Indirect methods".

All documents have been circulated twice to CCT-WG5, and then twice to CCT and CCPR and all comments addressed. The latter two are now complete and ready, in the view of WG5, for incorporation into the appropriate parts of the *MeP*-K. Two issues remain in the background document (CCT/10-12). The first concerns the role of gas refractive index and its influence on radiation transfer. This issue will be addressed at the forthcoming "Blackbody Users Group" meeting at Tempmeko on 4th June. The second concerns developing revised values for the HTFPs and MS has agreed produce revised values by the end of 2010. It was felt appropriate to delay undertaking this later task until after Tempmeko '10 as new values will be reported there.

This work has led to a keynote address at Tempmeko '10 (from GM), and a themed session concerning the implementation of primary radiometric temperature measurement, also at Tempmeko '10.

Action04: GM to recommend to the CCT acceptance of the three CCT/10-12 documents, and that the two documents CCT/10-13 and CCT/10-14 be forwarded to WG1 for incorporation into the text for the *MeP*-K.
Action05: GM and TG for *MeP*-K HT to finalise background document CCT/10-12 by; resolving of remaining issues concerning the refractive index and agree revised values of HTFPs (led by MS)
Action06: WG5 – all WG5 members to send any new measured values of HTFPs to MS (LNE-INM/Cnam)

New measurements of ITS-90 radiation thermometry defining fixed points
FG (INRIM) and MS (LNE-INM/Cnam) reported new measurements of the defining fixed points of the ITS-90 of Ag, Au and Cu. A technical discussion was held concerning the methods, procedures and results. INRIM will present these results more fully at Tempmeko '10, LNE-INM/Cnam in a forthcoming paper after Tempmeko '10. Other participants indicated they had new measurements of these fixed points, e.g. NMIA. MB (INRIM) has

agreed to collect and collate these measurements into a report to WG4 on new evaluations of the defining fixed points of the ITS-90 for radiation thermometry.

Action07: WG5 members to send new measurements of ITS-90 defining fixed points for radiation thermometry, either intervals or *T* determinations, to MB (INRIM). MB to produce a summary document by end 2010.

IEC Specification standards for radiation thermometers and thermal imagers

The IEC standards committee SC65B WG5 "temperature sensors and instruments", whose convenor is Masahiko Gotoh, has formed two sub-groups; one on radiation thermometry the other on thermal imaging.

JHt (PTB) is chair of the committee concerned with "Technical specifications of radiation thermometers". This activity began several years ago and the technical standard is now complete and published (IEC/TS 62492-1). The sub-group is now drafting a standard concerned with how to measure the quantities given in the first document (IEC/TS 62492-2). This sub-group will meet on 1 June at Tempmeko '10.

GM (NPL) is the chair of a new committee concerned with identifying and defining "Specification standards for FPA thermal imagers", this sub-group has only recently been formed and will have its first meeting on 31st May at Tempmeko '10.

Uncertainty document for thermal imagers

A discussion was held concerning the requirement of an uncertainty document for the calibration of thermal imagers. Although it was felt such a document is required, the timing is not yet appropriate due to the rapid developments in the field. Instead it was agreed that a survey of current calibration practice of thermal imagers within the NMIs would be performed. MB (NMIA) agreed to formulate the questionnaire, coordinate responses and provide a summary that could be uploaded onto the WG5 section of the BIPM website. He will give a report of the questionnaires findings at the next WG5 meeting held at CCT.

Action08: MB (NMIA) To send questionnaire concerning calibration of thermal imagers to chair of WG5 for circulation to WG5 members. MB will then collate answers, write summary suitable for uploading onto BIPM website (WG5 area) and present findings at next WG5 meeting

Action09: WG5 to complete questionnaire on thermal imaging calibration and return to MB within 1 month of receipt

High Temperature Fixed Points (HTFP), research plan progress

To solve remaining technical issues surrounding the use of HTFPs a subgroup of CCT-WG5 developed coordinated "action plan". Full details of the plan can be found on the BIPM website at:- http://www.bipm.fr/wg/CCT/CCT-WG5/Allowed/Miscellaneous/CCT-WG5-docs-01.pdf. The plan defined the research priorities for next 5-7 years in this field to progress HTFPs from a research topic to mainstream metrology tools.

The work is approximately half way completed. Reports were given by two participants; LNE-INM/Cnam (stability studies), [MS] and PTB (test of primary radiometric capability), [JH].

MS reported the first results of long-term stability and robustness studies of a set of HTFP cells. The results were very encouraging and will inform the design of the "primary" level HTFP cells for *T* assignment.

A draft document on the construction of the "primary" cells for *T* assignment has been prepared by YY for discussion.

HTFP fixed-point operational requirements, studies are underway in various NMIs, led by PB.
A high level comparison of world radiometric capability of PTB, NPL, NIST, NMIA, LNE-INM/Cnam, KRISS and VNIIOFI is underway. Preliminary results reported at the WG5 meeting by JH indicate good agreement of the primary radiometric scales of PTB and NPL. The HTFP cells have been measured at NIST and are currently at NMIA awaiting measurement. A second loop is about to start involving PTB, LNE-INM/Cnam, KRISS and VNIIOFI.
The last technical step is to plan and perform *T* measurements for definitive HTFP cells. This will be led from NPL and begin about 6 months after the completion of the assessment of world radiometric capability to allow time for improvement actions to be performed.

This project has been very fruitful technically. It has already led to a large number of technical papers and another set will be presented at Tempmeko '10. A planning meeting was announced for Tempmeko '10 (4th June pm) where the second phase of this project will be discussed and agreed.

MB gave a presentation of NMIA capability at high temperatures and the use of HTFPs for thermocouple calibration. He also presented some modifications made by NMIA, guided by thermal modelling, to the thermogage furnace work tube to improve furnace uniformity.

Ken Hill indicated that NRC was interested in joining the *T* assignment, or even assessment of radiometric temperature measurement if one of the other partners proved unable to participate. HY suggested that NIST could send NRC their HTFP cells to undertake a bi-lateral comparison of capability.

JH is standing down from this activity and WG5 due to new responsibilities in PTB. GM thanked JH for his contribution to WG5. Klaus Anhalt will take on JH responsibilities in HTFP work and be a co-opted member of WG5.

Action10: GM and YY to agree HTFP construction document draft and circulate to WG5 and other interested parties for comment
Action11: GM invite NRC to participate in planning meeting of HTFP research at Tempmeko '10

Earth Observation requirements
NF then gave an informative tutorial on the EO communities requirements for temperature and radiometric measurements. He explained the large infrastructure that was in place coordinated by CEOS (Committee on Earth Observation Satellites). Stressed that the community is very interested in improving the quality of its data, gain a clearer understanding of how to estimate uncertainties and pursue traceability to the SI where possible. This was underlined by the World Meteorological Organisation (WMO)-BIPM joint workshop of "Measurement Challenges for Global Observation Systems for Climate Change Monitoring: Traceability, Stability and Uncertainty" Geneva 2010 and the signature of the CIPM MRA by the WMO.
More information about this topic can be found at the following website: http://www.bipm.org/en/events/wmo-bipm_workshop/

Action12: NF to send WG5 chair copy of his presentation for uploading onto BIPM website as a WG5 document

Radiation thermometry text for updated "supplementary information"

Discussion was held on what to do concerning text for the radiation thermometry part of the "supplementary information". It was felt that there is a lot of information already published and most WG5 members felt it would not, presently, be a productive use of the committee's time, though may become so later. Books like DeWitt and Nutter and Zhang, Tsai and Machin were cited as appropriate starting points for budding practitioners.

Action13: GM to discuss with chair of WG1 concerning how best to provide appropriate input into the Supplementary information for radiation thermometry methods. [Note subsequent to WG5 meeting MM informed WG5 chair that he had drafted some text suitable for "Supplementary information" and he agreed to forward. Action postponed until MM text reviewed].

AOB, Announcements

The following meetings were announced to the participants:

IEC Thermal Imager Specification Standards 31st May Tempmeko '10, IEC, Seattle Oct 10

IEC Radiation Thermometry Standards 1st June Tempmeko '10

Blackbody Users Group 4th June Tempmeko '10 (am) (refractive index)

HTFP plans and prospects 4th June Tempmeko '10 (pm) – for HTFP research plan participants

It was proposed to hold the next meeting of CCT-WG5 at Newrad '11.

MM announced a temperature measurement conference to be held in St Petersburg either in April/May 2011.

Action 14: MM to keep WG5 informed of details of Temperature Measurement Conference in Russia 2011

Close of meeting

Chair thanked all participants for their contributions. The meeting finished at ~12:45, with lunch.

Appendix I: Draft agenda of CCT-WG5 meeting 6 May 2010

Chair: Graham Machin
Time: 8:30-13:00
Location: BIPM, Paris

8:30-8:45 Welcome (GM), members introduction (all)
8:45-9:00 Review of minutes and action record of last meeting (21st May 2008)
9:00-9:15 Review of terms of reference and tasks – any recommendations for changing these to be proposed to the CCT?
9:15- 9:30 The mise-en-pratique for the kelvin at high temperatures (GM)
9:30-10:00 New measurements of ITS-90 defining fixed points (MS, MB, others)
10:00-10:15 IEC Specification standard for radiation thermometers (JHt)
10:15-10:30 IEC Specification standard for Thermal imagers (GM)
10:30-10:45 Uncertainty document for thermal imagers – how/if/when to proceed 10:45-11:00 High Temperature Fixed Points (HTFP), research plan progress (GM, MS, JH) – part I
11:00-11:20 Coffee
11:20-11:40 High Temperature Fixed Points (HTFP), research plan progress (GM, MS, JH) – part II
11:40-12:30 Earth Observation requirements (presentation by NF, followed by discussion)
12:30-12:45 Discussion re future KC
12:45-12:55 Radiation thermometry text for updated "supplementary information"
12:55-13:00 AOB, Announcements – meetings at Tempmeko '10, New kelvin dissemination workshop, Next meeting Newrad 11?
13:00 Close of meeting

Appendix II: Action record of CCT-WG5 6th May 2010

Action01: GM to inform chair of Euramet TCT that a regional comparison of radiation thermometry below the silver point should be initiated to support services offered and claimed cmc entries.

Action02: GM to include on agenda for next CCT-WG5 meeting at CCT (May 2012) proposals for KC above the silver point

Action03: GM to recommend to CCT additional task for WG5 concerning key comparisons

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