CCT-WG5 Activity Report May 2010 to May 2012

Report prepared by: Graham Machin, NPL
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This report details the activities undertaken by CCT-WG5 over the period between CCT/25 and CCT/26. With such a busy and active group it is impossible to capture all our activities only highlights will be given.

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

Members: As agreed at CCT, May 2010

A*STAR (Wang Li), CEM (Maria Jose Martin Hernandez), CENAM (Daniel Cardenas-Garcia), Renato Teixeira (INMETRO), INRIM (Ferruccio Girard), KRISS (Chul Woung Park), LNE-INM/Cnam (Mohamed Sadli), MSL (Peter Saunders), NIM (Zundong Yuan), NIST (Howard Yoon), NMIA (Mark Ballico), NMIJ (Juntaro Ishii), NPL (Graham Machin, chair), PTB (Joerg Hollandt), SMU (Peter Nemecek), UME (Ahmet Diril), VNIIM (Mikhail Matveyev), VSL (Eric van der Ham), CCPR official representative (Nigel Fox)

Co-opted members
NIM (Tiejun Wang), NIM, formerly NMIJ and VSL, (Pieter Bloembergen), NMIJ (Yoshiro Yamada), Emma Woolliams (NPL), PTB (Klaus Anhalt), VNIIOFI (Boris Khlevnoy)

Membership changes:
Andrew Todd (NRC) became a member of the group [Dec 11]
Eric van der Ham was replaced by Elena Ravtova and subsequently Edgar Moreno Vuelban (VSL) [Apr 12]

List of meetings held in period May 2010 to May 2012
A formal meeting of CCT-WG5 was held during the reporting period alongside CCT2010 respectively. Links to the minutes are given below.

CCT-WG5 21st May 2010
Minutes of that meeting can be found at:
http://www.bipm.org/cc/CCT/Allowed/25/D38_WG5_minutes_6_May_10_v2.pdf

The full WG5 plans to meet again until at CCT/26 on 22nd May 9:00-13:00 at the BIPM.

Other CCT-WG5 meetings and associated workshops

BlackBody Users Group (BBUG)
BBUG is a loose affiliation of users interested in all aspects of blackbody metrology. Its meetings are sponsored by CCT-WG5. The second and third meetings of the Blackbody Users Group (BBUG) were held during Tempmeko '10 (4th Jun 2010) and ITS9 (19th Mar 2012) respectively. The first meeting was organised by GM in cooperation initially with PTB radiometry colleague Peter Sperfeld and then Klaus Anhalt. The second meeting was organised by Martin Dury (NPL) who is now the coordinator of these events. The minutes of both meetings can be found at http://www.bipm.org/jforum/forums/show/31.page. It is anticipated that the next meeting of BBUG will be held at Tempmeko '13.

HTFP meetings
Two meetings were held, one at Tempmeko '10 (4th Jun 2010) and another at ITS9 (19th Mar 2012) to advance the research towards assigning thermodynamic temperatures to a selected set of HTFPs. Minutes on the meetings are available on request from GM. An additional HTFP meeting is going to be held on 22nd May 2012 (led by EW, NPL) to focus on the measurement aspects of thermodynamic temperature assignment.

Planned meeting – Primary radiometric temperature determinations -Autumn 2012
A meeting sponsored by CCT-WG5 (and Euramet TCT) will be held in the Autumn of 2012 on "Primary radiometric temperature determinations" with special emphasis given to the determination of uncertainties. This workshop will be organised by MS (LNE-INM/Cnam).

Documents
Text for the high temperature section of the MeP-K
A subgroup of WG5 produced significant textual input for the *MeP*-K high temperature section. These documents were accepted at CCT2010 and links are given below. The direct and indirect methods documents will abstracted after the 2012 CCT meeting for inclusion in the *MeP*-K.
http://www.bipm.org/cc/CCT/Allowed/25/D12r_MeP-HT_v8.pdf
http://www.bipm.org/cc/CCT/Allowed/25/D13_MeP-direct_method_v3.1.pdf
http://www.bipm.org/cc/CCT/Allowed/25/D14_MeP-indirect_method_v3.1.pdf

The importance of this work was recognised by the international temperature community through the presentation of an invited address on the *MeP*-K HT work of

WG5 at Tempmeko ’10. In addition there was a dedicated session at Tempmeko ’10 arising from the work of this task group describing different technical aspects of radiometric temperature measurement.

Text for the Sinf for the ITS-90

A sub-group of WG5 (MJMH, MM, AT and Helen McEvoy [NPL]) chaired by HY (NIST) is leading the development of new text for the *Sinf* relating to radiation thermometry. This is now in an advanced state and will be discussed at the CCT-WG1 meeting on 22 May 2012. It is anticipated that shortly after that meeting the text will be completed and the radiation thermometry part of the *Sinf* be completed. Many thanks to HY for coordinating this activity.

High temperature fixed point research

A summary of the work, since the 2010 CCT, is given below:

HTFPs of Co-C, Pt-C and Re-C have had initial long-term stability assessed [WP1]. Innovative work has been undertaken at, in particular, LNE-INM/Cnam and NMIJ to solve on-going robustness problems with Co-C.

PTB has made baseline *T* assessments of these HTFPs. These were then circulated to and measured by NPL, NIST, NMIA, LNE-INM/Cnam, NRC and VNIIOFI. A paper was presented in these results at ITS9 by KA. These measurements provide a baseline assessment of the status of world radiometry, with recommendations for improvements to primary radiometric thermometry [WP4].

A set of high quality cells of Co-C, Pt-C and Re-C have been made by various institutes [WP2] for final *T* assignment by enhanced primary radiometry in 2012-2015 [WP5]. In addition a number of Cu points have been constructed to provide the linkage with ITS-90 and to redetermine the thermodynamic temperature of the Cu point. Pre-selection tests were reported at a meeting at the ITS9 and as a result four Cu, Co-C and Pt-C cells were identified for entry into the T assignment. The results for the Re-C were ambiguous and NIM is currently in the process of re-evaluating the data with a view to agreeing which Re-C cells will be suitable for T assignment by the end of May.

WP3 is leading work examining operational characteristics of HTFPs to develop a rigorous uncertainty budget for the *T* assignment. This is well underway, led by NIM, NMIJ and NPL.

In addition the protocol for WP5 “Radiometric temperature assignment to Co-C, Pt-C and Re-C” is in draft form. This will form the topic of discussion at the HTFP satellite meeting on 22nd May 2012 (pm) at BIPM, Sevres. Finally this WP is now part of the EMRP Implementing the new kelvin project which will start in Oct 2012.

Thermal imaging

Thermal imaging survey

At the May 2010 WG5 meeting it was decided to perform a survey of calibration capability and requirements for thermal imaging among the NMIs in the regions. Mark Ballico (NMIA) produced a questionaire and this was circulated among some of the metrology regions. NPL and NMIJ are coordinating the responses for Euramet and APMP respectively. A summary of findings will be presented at the next WG5 meeting in 2012. This work is the first step in understanding what the requirements are for thermal imaging calibration capabilities in the NMIs into the future.

Input into standardisation of thermal imagers and radiation thermometers
WG5 members are contributing to both the following two ISO/IEC committees.

- Specification standards for thermal imagers. Progress was made to agreeing the parameters for FPA thermal imagers that should be included in the standard. However due to other commitments GM had to resign as chair of the committee and in the interim is being chaired by Masahiko Gotoh.

- Specification standards for radiation thermometers: IEC/TS 62492-2 Industrial Process Control Devices – Radiation Thermometers - Part 2: Determination of the Technical Data of Radiation Thermometers (chaired by Joerg Hollandt, PTB). The New Work Item Proposal (65B/806/NP) has been approved by voting in Dec. 2011, 18 P members approving. Active participation approved by China, Germany, Great Britain, Italy and Japan. There was an IEC SC65B WG5 meeting at ITS-9: All comments of the national committees (65B/821/RVN) were discussed and accepted, NP to be sent shortly to IEC Central Office as the CDV.

Key comparisons
The KC5 strip lamp comparison was completed in 2008 and the values entered onto the KCDB. This KC took over ten years to complete and in common with many KCs it does not substantiate cmc entries as far as uncertainty values are concerned (nor temperature range that NMIs are now using). Any future KC will address this issue and initial discussions about a new KC planning will be held at the WG5 meeting held in conjunction with CCT/26. However it is thought that the only realistic means of probing a primary realisation of the ITS-90 above the Ag point, with the lowest uncertainties, is with a set of HTFPs. It would be anticipated that a number of NMIs would perform the KC using HTFPs, and then the regional loop would be performed – either with HTFPs or with a radiation thermometer – dependent upon the regional requirements/capability. It was found at the recent Euramet TCT meeting (Apr 12) that about 15 additional NMIs within Euramet would wish to take part in the second loop.

Annex 1: Action record of CCT-WG5 21st May 2010, BIPM, Sevres, Paris

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. DONE
Action02: GM to include on agenda for next CCT-WG5 meeting at CCT (May 2012) proposals for KC above the silver point - DONE
Action03: GM to recommend to CCT additional task for WG5 concerning key comparisons – DONE and AGREED
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 – DONE and AGREED
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) Only HTFP values left
Action06: WG5 – all WG5 members to send any new measured values of HTFPs to MS (LNE-INM/Cnam)
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.
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. Latter half not done BUT Euramet and APMP presentation at next WG5 on findings.
Action09: WG5 to complete questionnaire on thermal imaging calibration and return to MB within 1 month of receipt – NOT DONE
Action10: GM and YY to agree HTFP construction document draft and circulate to WG5 and other interested parties for comment DONE
Action11: GM invite NRC to participate in planning meeting of HTFP research at Tempmeko ’10 - DONE
Action12: NF to send WG5 chair copy of his presentation for uploading onto BIPM website as a WG5 document – NOT DONE
Action13: GM to discuss with chair of WG1 concerning how best to provide appropriate input into the Supplementary information for radiation thermometry methods. Sub-group of WG5 under HY leadership providing input – in progress
Action 14: MM to keep WG5 informed of details of Temperature Measurement Conference in Russia 2011 - - DONE

Annex 2: Agenda of CCT-WG5 to be held 22nd May 2012, BIPM, Sevres, Paris

Draft agenda for CCT-WG5 Radiation Thermometry

Date: Tuesday 22 May 2012

Time: 9:00-13:00

Venue: BIPM, Sevres

Draft agenda

1. Introduction of participants and new members [all]
2. Review of last minutes and action record [GM]
3. Review of regional thermal imaging services; Euramet Helen McEvoy, APMP Juntaro Ishii
4. Best practice guidance on thermal imager calibration – new TG? [GM]
5. SInf TG progress report [HY]
6. Completing the HT MeP-K text for inclusion in the MeP-K [GM]
7. Linkage of HTFP work to the EMRP InK project [GM]
8. Key comparison with HTFPs – planned start date Autumn 2013 – [GM & MS]
9. Progress of WG5 HTFP research plan [GM]
10. Progress with WP1 (HTFP stability and next measurements) [MS]
11. Progress with cell selection for T assignment [WP2] [YY]
12. Progress with primary radiometry [WP4] [KA]
13. T assignment protocol [WP5], satellite meeting this afternoon [EW]
14. Report from CCPR [EW]
15. AOB