

CCT-WG5 Activity Report May 2012 to May 2014

Report prepared by: Graham Machin, NPL
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This report details the activities undertaken by CCT-WG5 over the period between CCT Convocations CCT/26 and CCT/27.

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 2012

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

Membership changes:

KRISS nominated Seon Do Lim to replace Chul Woung Park as CC delegate

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)

List of meetings held in period May 2012 to May 2014

A formal meeting of CCT-WG5 was held during the reporting period alongside CCT2012 respectively. Links to the minutes where available are given below.

CCT-WG5 22nd May 2012, BIPM, Paris

Minutes of that meeting can be found on the restricted access webpages of the CCT-WG5. Action record of that meeting given in Annex 1 and Agenda given in Annex 2.

CCT-WG5 18th Oct 2013, Funchal, Tempmeko '13

Minutes of that meeting can be found at:

http://www.bipm.org/wg/CCT/CCT-WG5/Allowed/WG5_Meeting_2013/CCT-WG5_Meeting_Minutes_Tempmeko13_v2-1.pdf

Action record of that meeting given in Annex 3 and Agenda given in Annex 4.

CCT-WG5 19th May 2014, BIPM, Paris

WG5 will next meet at CCT/27 on 19th May 14:00 to 18:00 at BIPM, Petit Pavillon.

Other CCT-WG5 meetings and associated workshops

Primary radiometric temperature determinations – 12 October 2012

A workshop sponsored by CCT-WG5 (and Euramet TC-T) was held at INRIM on the topic of “Primary radiometric temperature determinations” with special emphasis given to the determination of uncertainties. The presentations from the workshop are available from the restricted access webpages of the CCT-WG5. As a result of this workshop EW agreed to lead a TG within WG5 to formulate definitive guidance on uncertainties in primary radiometric temperature measurement. This workshop was organised by MS (LNE-INM/Cnam).

Documents produced or under development

Text for the high temperature section of the MeP-K

A summary of the high temperature MeP-K text was produced in the first part of 2013. This is now part of the MeP-K-14 and will be discussed at the CCT-2014.

Text for “Supplementary information” and “Approximating techniques” for the ITS-90

A task group (TG) of WG5 (MJMH, MM, AT and Helen McEvoy [NPL]) chaired by HY (NIST) is leading the development of new text for the *Sinf* and *AppT* relating to radiation thermometry.

Text was produced for *Sinf* Ch 6 describing the establishment of the ITS-90 above the silver point. After the WG5 meeting in May 12 some amendments to the text were required and the revised text will be presented to the next WG5 meeting in May 14.

Text is required for the approximating techniques for the ITS-90. This is for realisation of ITS-90 below the silver point by radiation thermometry through calibration by fixed point blackbodies. This TG is drafting text for this and progress will be reported at CCT-WG5 in May 14.

Many thanks to HY for coordinating this activity.

Text for primary radiometric temperature uncertainties

A task group (TG) of WG5 (MS, HY, KA, AT, PS [with technical experts Stéphan Briaudeau (CNAM) and Dieter Taubert (PTB)]) chaired by EW (NPL) is developing a definitive guidance document on uncertainties in radiometric temperature measurement. A first draft was produced by EW and this was discussed and revisions proposed at the CCT-WG5 meeting in Funchal Oct 13. A second draft is in production and will be discussed at the CCT-WG5 meeting in May 2014.

High temperature fixed point research

The assignment of thermodynamic temperatures is now being performed as part of WP1 of the Euramet Metrology Research Programme project “Implementing the new Kelvin” <http://projects.npl.co.uk/ink/>. The project started in Oct 12 and will complete in Sep 15. As part of that project the thermodynamic temperature of HTFPs of Co-C, Pt-C and Re-C will be performed by the participants and consensus temperatures for each fixed point calculated by EW of NPL. In addition the thermodynamic temperature of the Cu point will also be re-evaluated. To date measurements have been performed at NPL (relative to determine the cell differences), NRC, NIST, VNIIOFI, PTB with measurements to be performed by NIM, NMIA, CEM and CNAM. The selected cells have performed well with no breakages to date (Apr 14). Currently the measurements are on schedule to complete by the end of 2014 according to the InK measurement schedule.

In parallel, work has been performed by NIM, KRISS, NPL (and the University of Cantabria, Spain) and others to quantify corrections/uncertainty components for temperature drop, furnace effects and residual impurities.

Thermal imaging

A review of thermal imaging services was undertaken in the APMP (led by JI) and Euramet (led by HCM) and results reported to the WG5 on May 12. This promoted a discussion about the requirement for a comparison of thermal imager calibration methods, and whether CCT-WG5 should establish a task group on thermal imager calibration. It was decided to wait until the IEC committee on this issue had been reactivated and reported, however to date (Apr 2014) there has been no progress with the IEC activity. In addition it is important to restrict the comparisons led from WG5 to the most critical and that was felt to be ITS-90 above the silver point (see immediately below).

Key and regional comparisons

New key comparison above the Ag point

Intensive RMO discussions took place in the first part of 2013, with the help of Ken Hill, chair of CCT-WG7 and the president of the CCT concerning a potential key comparison above the silver point. As a result of those discussions it was agreed that a new key comparison above the silver point would be launched from CCT-WG5 sometime in 2014. The general outcome of those discussions were:

A. The prototype KC with HTFPs that was discussed at the last CCT-WG5 meeting (May 12) will be subsumed into the CCT-Kx - and will not now link with the InK HTFP circulation which will remain within Euramet.

B. The CCT-KCx will use a radiation thermometer and at least two doped HTFPs will be circulated to be optionally measured to probe scale realisation uncertainties at their temperatures.

C. The CCT-WG5 meeting at Tempmeko 13 will have this topic as one of its main agenda items where the following will be discussed:

- 1) the form of the KC
- 2) an institute willing to write the protocol and lead the KC
- 3) a suitable transfer instrument needs to be specified
- 4) Identify participating institutes (willing to provide local RMO linkage after the KCx is performed)

At the CCT-WG5 meeting at Funchal 18th Oct 2013 very fruitful discussions were held. The minutes are available on the above link but in brief it was agreed that:

- a) The comparison would take the form of a collapsed star
- b) NPL would pilot and HCM would lead this activity on behalf of CCT-WG5
- c) Transfer artefacts would be a Chino 650 nm radiation thermometer supplied by NMIJ, and LP3 supplied by PTB and a travelling Cu point supplied by NRC.
- d) HTFPs would be used but only those either doped or not well investigated. These will be used to probe scale realisation uncertainties at specific temperatures. Subsequently it was agreed to use doped Ni-C, Ru-C and WC-C.
- e) Participants agreed were SIM: NIST, NRC; COOMET: VNIIM; EURAMET: NPL, PTB, CEM and Cnam/LNE and subsequent to the meeting APMP: NIM, NMIJ and KRISS

A protocol has been drafted and circulated, comments received and the second version will be discussed at the WG5 meeting in May 14. It is anticipated that the KC will start in the autumn of 2014.

Regional comparisons APMP T-S11 and T-S12

Details of this were reported at the CCT-WG5 meeting on 18th Oct 2014. This is planned to take place between 2013 and 2016 with NMISA being the first participant. T-S11 covers the range 156 °C to 2000 °C with two radiation thermometers (0.9 µm and 1.6 µm) and a range of fixed points (In to Cu). T-S12 covers the same range as the CCT-WG5 KC so the issue of linkage was discussed and APMP T-S12 will be renamed to be consistent with the CCT-WG5 KC. It was agreed that provided the protocols were similar and the timeframes reasonably congruent (with hopefully the CCT-WG5 KC completing first) then there should be no problem linking the APMP regional comparison with the KC.

Annex 1: Action record of CCT-WG5 22nd May 2012, BIPM, Sevres, Paris

AP.2012-01: MS to discuss with others how to deal with T and T_{90} values and then send out a revised list of HTFP temperatures incorporating WP4 (of HTFP research plan) values. SUPERCEDED. Now part of InK WP1

AP.2012-02: GM to talk with the IEC interim committee chair to understand timescales for that committee and to report back to the CCT-WG5. DONE and no action taken by IEC chair

AP.2012-03: GM to discuss with WG2 chair including radiation thermometry below the silver point using ITS-90 fixed points in the “Approximating techniques for the ITS-90” revision. DONE and see AP4 below.

AP. 2012-04 HY to lead activity within WG5 in developing appropriate text for the “Approximating techniques of the ITS-90” using the fixed-point interpolating method of realising ITS-90 for radiation thermometry below the silver point. IN PROGRESS

AP.2012-05: EW to find appropriate reference on subtractive mode double monochromators and Howard Yoon to introduce this to text before final draft circulated. EW DONE – Final draft to be circulated.

AP.2012-06: GM to take YY concerns to CCT-WG1 and to provide feedback on how MeP-K will be structured. GM to write shortened text for MeP-K, as required. DONE

AP.2012-07: MS to prepare a 1-page advertisement for the uncertainties workshop and send out to the CCT and CCPR. All to send MS ideas on discussion topics for the workshop DONE.

AP.2012-08: FG to ask INRIM/Roberto Gavioso if video links/webex would be possible during the workshop. DONE

AP.2012-09: GM to raise discussion at CCT about the role of a KC. DONE

AP.2012-10: EW to provide GM with the CCPR guidelines for comparisons. GM to forward to CCT-WG responsible for KC. DONE

AP.2012-11: GM to ask NPL to make a Co-C cell. YY to ask VNIIOFI to do so. DONE

AP.2012-12: YY to prepare paper for publication on the work of WP2. DONE

AP.2012-13: GM to arrange for the executive secretary of the CCT to put the presentations given at this meeting on the CCT website and circulate the password. DONE

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

Agenda for CCT-WG5 Radiation Thermometry

Date: Tuesday 22 May 2012

Time: 9:00-13:00

Venue: BIPM, Sevres

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

Annex 3: Action record of CCT-WG5 18th Oct 2013, Funchal Madeira, Tempmeko '13

From Discussion Point 1: *Introduction*

EW will write up the formal minutes and provide these to GM for editing and circulation by 22nd October 2013 –DONE

From Discussion Point 2: *Radiometric uncertainty document*

- **EW** will change the Terms of Reference of the FR Uncertainties Task Group to have a completion date of May 2014 and to include PS and AT as members (by 22nd October 2013). DONE
- **GM** will inform the CCT Secretary to add PS and AT as task group members - DONE
- **EW** will circulate (by 25th October 2013) existing draft to all members of CCT-WG5, with a second email to task group members asking them to edit the text of specific sections. DONE
- **TG Participants** will provide edited sections to EW by the 15th November NOT DONE
- **EW** will send out a full draft to task group members by 6th December. The task group will circulate a complete report in a near-final form to the members of CCT-WG5 in advance of the May 2014 meeting. NOT DONE

From Discussion Point 4: *New KC above the silver point*

- **HCM** will prepare a draft protocol, based on the decisions listed above and taking into account the MRA comparison guidelines, by January 2014, which will be circulated to both the CCT-WG5 and the CCT-WG7 for comment. DONE. The aim will be for the protocol to be accepted by the CCT in May 2014 and the comparison will start in Summer 2014.
- **YY** will send HCM and GM the protocol of the APMP-S-T12 comparison for reference, by end October 2013. DONE
- **KA** will confirm in writing that the LP3 is available for use DONE
- **YY** to confirm in writing that the Chino-RT is available for use. DONE
- **AT** to confirm in writing that the Chino Copper Point is available for use DONE.
- **KA, YY and AT** to provide information about the operation of these instruments to Helen McEvoy for inclusion in the protocol.
- **GM** lead email discussion to confirm the HTFPs to be used in the comparison. This will include confirming whether NPL could make doped-Re-C or Ir-C cells or whether WC-C cells are sufficient. INMETRO to provide 3 doped Ni-C (or Co-C) cells. DONE
- **GM** discuss NMISA's participation in the light of four qualifying APMP NMIs and because NMISA is participating in the APMP –T-S12. DONE
- **APMP** to confirm who will participate in the KC by end of Nov. DONE

Annex 4: Agenda of CCT-WG5 18th October 2013, Tempmeko '13, Funchal, Madeira

CCT WG5 meeting

Location: Tempmeko 13, Funchal, Madeira

Date: 18th October 2013, time: 14:00-17:00

Agenda:

1. Introductions (all)
2. Radiometry uncertainty document (EW)
3. APMP comparison above the silver point (YY)
4. CCT KC above the silver point (GM, HCM, all)
 - a) the form of the KC
 - b) an institute willing to write the protocol and lead the KC
 - c) a suitable transfer instrument (and travelling fixed point) needs to be specified
 - d) Identify participating institutes (they must be willing to provide local RMO linkage after the KCx is performed - and leadership of any subsequent RMO comparison)
5. AOB