

## **Minutes of CCT-WG5 Meeting**

**Chair:** Graham Machin  
**Date:** 18 October 2013  
**Time:** 14:00 – 17:00  
**Location:** Tempmeko Conference, Funchal, Madeira

### **Attendees**

#### **Attending Members**

A\*STAR (Wang Li), CEM (Maria Jose Martin Hernandez), CENAM (Daniel Cardenas-Garcia), INMETRO (Renato Teixeira), INRIM (Ferruccio Girard), KRISS (Seon Do Lim), LNE-INM/Cnam (Mohamed Sadli), MSL (Peter Saunders), NIM (Zundong Yuan), NMIA (Eric van der Ham represented Mark Ballico), NMIJ (Juntaro Ishii), NPL (Graham Machin, chair), NRC (Andrew Todd), PTB (Klaus Anhalt (co-opted member represented Joerg Hollandt)), UME (Ahmet Diril), VNIIM (Mikhail Matveyev), VSL (Edgar Vuelban),

#### **Attending co-opted members**

NIM, formerly NMIJ and VSL, (Pieter Bloembergen), NMIJ (Yoshiro Yamada), Emma Woolliams (NPL), PTB (Klaus Anhalt), VNIIOFI (Boris Khlevnoy)

#### **Attending observers**

CEM (Jose M. Mantilla), NIMT (Narudon Noulkhow), NMIJ (Yukiko Shimizu), NPL (Helen McEvoy), NRC (Ken Hill), PTB (Dieter Taubert), VNIIM (Viktor Fuksov)

#### **Apologies & non attending**

CCPR official representative (Nigel Fox) (NA), (NIST) Howard Yoon (A), SMU (Peter Nemecek) (NA)

### **1. Introduction**

CCT-WG5 met on 18<sup>th</sup> September 2013 immediately after the Tempmeko 2013 conference. Actions arising from the discussions at this meeting are listed in Appendix 1, the agenda for the meeting is given in Appendix 2 the attendee list with email contacts are given in Appendix 3. Minutes were recorded by Emma Woolliams (NPL).

The meeting opened with the participants introducing themselves.

### **2. Radiometry uncertainty document**

The Task Group on Uncertainty Estimation in Primary Radiometric Temperature Measurement was set up in September 2012 with the aim to produce a document, written as a user guide, which will explain the main sources of uncertainty associated with radiometric

temperature measurement, and how these uncertainties can be reduced and quantified through experimental techniques.

It was hoped that the TG would have completed this activity by now unfortunately not that much progress has been made. A discussion was had about the purpose of the task group and the priorities for the report. It was generally agreed that the report should be finished, and that it should be written in a way that captures the general understanding that we all have gained through InK-WP1, on what the key uncertainty components are for filter radiometry. We all use somewhat different approaches, and the document should not emphasise a specific approach. Instead, it should look at common activities – for example, everyone, at some point in the calibration chain measures the area of two apertures and their separation, everyone has an amplifier that turns a photocurrent into a measurable signal. The emphasis should be on these building blocks, with a final section that gives example uncertainty budgets for the different methods.

### **3. APMP Comparison**

Yoshiro Yamada (NMIJ) presented the APMP comparisons APMP T-S11 and APMP T-S12, planned to take place during 2013-2016 (the artefacts have recently been shipped to the first participating laboratory NMISA). The comparison will have four subparts to it:

- Scale: 960 °C – 2800 °C, 0.65 µm radiation thermometer (T-S12)
- Scale: 400 °C – 2000 °C, 0.9 µm radiation thermometer (T-S11)
- Scale: 156 °C – 960 °C, 1.6 µm radiation thermometer (T-S11)
- Fixed Points: In, Sn, Zn, Al, Ag, Cu point blackbodies (T-S11)

The travelling standards are a Chino IR-R0A fixed-point blackbody furnace, which can take all the travelling fixed point cells and a number of Chino IR-RST radiation thermometers (different wavelengths). The comparison will be run as a star type, with artefacts returning to NMIJ after each participant, both for checks of stability and SSE and to simplify customs arrangements. Corrections to recorded values will be made by the pilot to account for differences in source sizes and measurement distances at the pilot and participants. The reference value will be calculated as a weighted-mean with cut-off, applying a chi-squared test to check for consistency.

Following YY presentation there was considerable discussion about the naming and linkage of the comparison. For pragmatic reasons, the APMP comparison was split into two and only T-S12 would link with the future CCT-KCx (see Section 4 below). The name of the APMP comparison can be changed in the future when the CCT-KCx is named. MRA rules require a link comparison to use the same type of artefacts as the CC Key Comparison, and any linkage with the old KC (K5) which used lamps is not appropriate. The new Key Comparison, will be of a similar form to APMP-T-S12 and with the objective of completing first. Once the CCT-KCx protocol has been approved, it will be possible to rename APMP-T-S12 in line with the new CCT-KC. Although the MRA officially requires a strict order with regards time, Ken Hill, representing CCT-WG7, said that as long as the new CCT-KCx had a similar enough protocol, and it finished on similar time frames (ideally the CCT-KCx finished first), there

should be no problem in linking the APMP comparison to it. WG5 agreed that, provided the appropriate CCT WGs agree, APMP will not have to repeat its comparison exercise after the new CCT-KCx is completed even though it started earlier.

Yoshi Yamada emphasised that the APMP comparison was of ITS-90 realisation and focussed on the CMCs. The travelling reference standards (fixed-points and radiation thermometers) represent typical 'customer DuTs'.

#### **4. CCT KC above the silver point**

Graham Machin first thanked APMP members, and Ken Hill of CCT-WG7, for their fruitful discussions from earlier in the year, which enabled the comparison to start.

Graham Machin led a discussion about the next CCT Key Comparison for temperatures above the silver point. This discussion covered the specific topics that Graham had emailed everyone in July 2013. The comparison will involve the circulation of both fixed-points (Cu and HTFPs) and two radiation thermometers.

##### **4.1: Form of the comparison**

Graham Machin proposed that the comparison should take the form of a 'semi-collapsed star'. In other words, the artefacts would be circulated from the pilot to a regional coordinator, would then run in a loop around a particular region, before returning to the pilot and being sent to the next regional coordinator. Within a region, the artefacts can travel on a carnet (if required).

In response to questions Graham Machin confirmed that he anticipated the loops would not run in parallel, but the artefacts would be circulated through each loop in turn. There was concern that artefacts could change during the loop part of the measurement. It was decided that if during a loop an artefact drifted too much, it should be sent back to the coordinator, rather than continuing, to allow the coordinator to determine the source of the problem through re-measuring linearity, SSE, etc. The protocol should include these criteria.

There was some concern to learn the essential lessons from CCT-K5. One of which was not to have two loops in one region. In addition it was decided that there should be two travelling radiation thermometers but that they should be of similar types, to simplify the analysis of the results.

With these cautions, the collapsed-star comparison form was accepted.

##### **4.2: Comparison Pilot**

Graham Machin confirmed that NPL (Helen McEvoy) would be willing to lead the comparison, and asked if anyone else was interested in the role. There was no response and NPL was accepted as the comparison pilot.

##### **4.3: Transfer artefacts**

Three types of artefact are needed for this comparison: radiation thermometer/s, and a reference fixed-point (Cu). In addition, to probe scale realisation uncertainties a number of high-temperature fixed-points of unknown temperature will be circulated.

For the radiation thermometers, PTB offered an LP3 (with 650 nm and 900 nm wavelengths), and NMIJ offered a 650 nm Chino device, similar to that used in the APMP comparison (with a 1 mm field of view). There were concerns that LP3 instruments can break during transportation (Klaus Anhalt said that during a EURAMET comparison, an LP3 gave a strange dark signal and had broken glass inside). But nobody has a spare LP3, and the LP3 has other advantages. For example it was considered a positive aspect that the LP3 had two wavelengths and it was felt that the protocol should include measurements at both wavelengths.

For a reference fixed-point, a travelling copper point was recommended. These cost at least 20kEuros. NRC (Andrew Todd) offered a new Chino copper point that they had as a travelling reference for the comparison. This was accepted.

For the HTFPs, there is the requirement that they are blind to everyone but the pilot. This means that well-known HTFPs cannot be used in their pure form. It also means that the doped cells could not be made by a participant of the comparison, except the pilot. Renato Teixeira of INMETRO has developed successful Ni-C-X doped fixed-points, and shown that the concept is possible for comparison artefacts. He confirmed his willingness to provide doped Ni-C or Co-C cells for this KC. There would need to be at least two (and perhaps three – to be confirmed, it depends on the risk of damage) cells of each type, to allow for a spare. The relative differences between the cells would need to be measured at the start and end of the comparison, but only one would be circulated.

After considerable discussion, it was decided that:

- NIM can already supply doped-Pt-C cells, but only if they are not chosen by APMP as participants of the comparison (see below)
- INMETRO to make new doped Ni-C or Co-C cells
- NPL would consider making either Ir-C cells, or doped Re-C cells (as pilot they could know the doping conditions)
- Ru-C cells could be used, if NIM is a participant and can't therefore make doped Pt-C cells
- Un-doped WC-C would be suitable as their temperature is not that well known and they are near the top temperature of the KC.

#### **4.4: Participants**

All participants must be willing to provide local RMO linkage after the end of the KC, including being willing to be pilot of the subsequent RMO comparisons. Ideally the comparison will be limited to 10 participants, in order to complete it as rapidly as possible to minimise the risk of artefact drift.

The suggested participants were:

- SIM: NIST, NRC
- COOMET: VNIIM
- Afrimets: NMISA?
- Euramet: NPL, CEM, PTB, Cnam/LNE
- APMP: 3 participants – APMP need to make the decision at their meeting in November.

APMP would like to have 4 participants. Since NMISA is taking part in APMP-T-S12 and since they cannot cover the full range, it was suggested that perhaps NMISA did not take part in this comparison and thus make space for a fourth APMP participant. Graham Machin agreed to discuss this issue with NMISA.

#### **4.5: General comments on comparison**

There was a question on there being two simultaneous comparisons (one with the RTs and one with HTFPs). What if there were discrepancies in the results between the two? The formal KC would be performed by the RTs. The HTFP comparison is to be seen as an additional ‘experimental’ comparison that would provide information specifically about the scale realisation uncertainties. The protocol section on HTFPs will be clearly distinct from the key comparison with the RTs.

It was recommended that during the agreement of the protocol for the new key comparison, RMOs consider how they will link to this. This is particularly important for APMP, who have already started their comparison. There was some discussion about whether APMP would have to repeat their comparison – and it was agreed that the APMP-T-S12 could link to this comparison later (see Section 3 above where this was also discussed).

The KC of RTs would not involve a full characterisation of linearity, SSE, etc., except by the pilot. Participants should calibrate them in their ‘normal way’.

The comparison analysis will be of a similar form to that of APMP-S-T12, and the results will be presented in a similar way.

In order to prepare for the comparison, a protocol should be approved by the next CCT-WG5 meeting (May 2014). To achieve this a draft protocol will be prepared by NPL (Helen McEvoy) by end January 2014 for circulation to both CCT-WG5 and CCT-WG7 for comment. The aim will be for the protocol to be accepted by the CCT in May 2014 and the comparison to start in Summer 2014. Yoshiro Yamada will send Helen McEvoy and Graham Machin a copy of the APMP-T-S12 comparison protocol.

#### **5. Any other business**

Howard’s report is postponed as he was unable to attend the meeting. It is hoped that his work will be able to continue by email.

Eric van der Ham asked about the formal linkage to CCPR. This remains with Nigel Fox, who has been copied in all reports. The decision on who the CCPR link is a matter for presidents of the CCPR and CCT.

### **Appendix 1: List of Actions and Conclusions**

Actions are given with bold names to indicate who the action is for.

From Discussion Point 1:

- **Emma Woolliams** will write up the formal minutes and provide these to Graham Machin for editing and circulation by 22<sup>nd</sup> October 2013 -DONE

From Discussion Point 2:

- **Emma Woolliams** will change the Terms of Reference of the FR Uncertainties Task Group to have a completion date of May 2014 and to include Peter Saunders and Andrew Todd as members (by 22<sup>nd</sup> October 2013). DONE
- **Graham Machin** will inform the CCT Secretary to add Peter Saunders and Andrew Todd as task group members - DONE
- **Emma Woolliams** will circulate (by 25<sup>th</sup> 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 Emma by the 15<sup>th</sup> November
- **Emma Woolliams** will send out a full draft to task group members by 6<sup>th</sup> 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.

From Discussion Point 3:

- CCT-WG5 thank APMP for their extensive work in preparing this comparison.
- Assuming that the appropriate WGs of CCT agree and that CCT-KCx above the silver point completes on a similar timeframe to APMP comparison, it should be possible to use the APMP comparison to provide formal linkage to that comparison. In that case, the APMP comparison will be renamed to emphasise that linkage.

From Discussion Point 4:

It was agreed that

- The comparison would take the form of a collapsed-star, with regional loops in sequence. Local regional coordinators would circulate the artefacts within a region.
- There would be two travelling radiation thermometers. An LP3 (provided by PTB) with two wavelengths, and a Chino (provided by NMIJ) at 650 nm.
- NRC would provide a Chino travelling copper point for reference purposes

- The specific cells used as the HTFP references need to be confirmed (see discussion above). Doped or poorly characterised HTFPs should be used. If doped HTFPs of Co-C, Pt-C or Re-C they should be made either by a laboratory that is not participating in the comparison or by the comparison pilot. Other participants cannot provide doped HTFPs, as these would not be sufficiently blind.
- NPL would act as pilot for the comparison
- The participants are as above apart from the fact that four (not three) APMP NMIs meet the qualifying conditions of KC. Because NMISA cannot meet the participation criteria and is participating in the APMP-T-S12 it will be asked to withdraw from the KC. APMP to decide which participants at next TCT meeting in November.
- The HTFP comparison is considered as a precise probe for testing scale realisation uncertainties. The formal CCT-key comparison will be that with the radiation thermometers.

Actions:

- **Helen McEvoy** 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. The aim will be for the protocol to be accepted by the CCT in May 2014 and the comparison will start in Summer 2014.
- **Yoshiro Yamada** will send Helen McEvoy and Graham Machin the protocol of the APMP-S-T12 comparison for reference, by end October 2013.
- **Klaus Anhalt** will confirm in writing that the LP3 is available for use.
- **Yoshiro Yamada** will confirm in writing that the Chino-RT is available for use.
- **Andrew Todd** will 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.
- **Graham Machin** will lead an email discussion to confirm the HTFPs that will 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 will provide three doped Ni-C (or Co-C) cells and what other cells will be used.  
UNDERWAY
- **Graham Machin** will discuss NMISA's participation in the light of four qualifying APMP NMIs and the fact that NMISA is participating in the APMP – T-S12. DONE
- **APMP** will confirm which of their members will participate in the KC by end of November.

## **Appendix 2: Agenda of meeting**

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

**Appendix 3: Participant list at CCt-WG5 meeting 18<sup>th</sup> Oct 2013**

Name	Institute	E-mail
Helen McEvoy	NPL	<a href="mailto:helen.mcevoy@npl.co.uk">helen.mcevoy@npl.co.uk</a>
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