

Report on the activities of the CCT WG-KC

October 20th, 2020



Overview

- Terms of reference
- Membership
- Overview of work performed by the WG
- Comparisons deviating from the CIPM/CCT process
- List of headings to guide the comparison pilots in preparing protocols and reports
- CCT document on sealed metal fixed-point cells
- Needs of future KCs and KCs testing thermodynamic temperature
- Analysis of key comparison results

Terms of reference

- *“To oversee all aspects of key comparison documentation*
 - *Starting with the Technical Protocol*
 - *Ending with the Draft B Report and the KCDB entry*

- *Including provision of advice to pilots on:*
 - *Calculation of the Degrees of Equivalence*
 - *Key Comparison Reference Value*
 - *Linkage between RMO and CIPM key comparisons”.*

- *In practice:*
 - *Review the initial Technical Protocol and all its subsequent iterations until approval*
 - *Review the Draft B Report and all its revisions until approval*

Membership

➤ Current membership:

- | | |
|----------------------|--|
| 1. Stephanie Bell | NPL (UK) |
| 2. Robert Benyon | INTA (Spain) |
| 3. Rien Bosma | VSL (the Netherlands) |
| 4. Helen McEvoy | NPL (UK) |
| 5. Christopher Meyer | NIST (USA) |
| 6. Andrea Peruzzi | VSL (the Netherlands) |
| 7. Steffen Rudtsch | PTB (Germany) |
| 8. Richard Rusby | NPL (UK) |
| 9. Gregory Strouse | NIST (USA) |
| 10. Andrew Todd | NRC (Canada) |
| 11. Rod White | MSL (New Zealand) → retired last week |
| 12. Inseok Yang | KRISS (Korea) |
| 13. Yuan Zundong | NIM (China) |
| 14. Megumi Akoshima | NMIJ (Japan) (proposed new member) |

Many thanks to
Yoshiro Yamada, NMIJ
(retired in 2019)

Overview of work performed by the WG KC since last CCT meeting

- In the past 3 ½ years, our services were requested by 44 different comparisons

Completed comparisons

- **14 approved comparisons:**
 - 6 RMO KCs
 - 2 CCT KCs
 - 1 CCT SC
 - 5 RMO SCs
- **1 abandoned comparison**
- **4 RMO SC's did not gain WG-KC approval**

Comparison ID	Type	Approval date
CCT-K9.1	KC	25-02-2020
CCT-K6.2	KC	24-02-2020
CCT-S2	SC	21-01-2020
APMP.T-K7.1	KC	06-11-2017
COOMET.T-S3	SC	11-03-2020
COOMET.T-S2	SC	07-07-2019
COOMET.T-K3.3	KC	02-02-2019
EURAMET.T-K7.1	KC	14-10-2019
EURAMET.T-S3	SC	07-07-2020
EURAMET.T-S4	SC	06-09-2017
EURAMET.T-S5	SC	21-03-2019
SIM.T-K6.2	KC	26-03-2018
SIM.T-K6.3	KC	26-03-2018
SIM.T-K6.7	KC	07-10-2019

Active comparisons (25) (showed progress in the past 3 ½ years)

Comparison ID	Protocol submitted	Protocol approved	Draft B submitted	Draft B approved
CCT-K6.1	21-10-2005	10-05-2006	07-10-2020	1 st review undergoing
AFRIMETS.T-S6	09-11-2017	1 st review transmitted 25-10-2018		
AFRIMETS.T-S7	09-11-2017	03-07-2018		
APMP.T-K4.2	13-11-2017	07-02-2018		
APMP.T-K8	25-04-2012	no	04-10-2019	2 nd review undergoing
APMP.T-S9	08-05-2014	13-02-2020		
APMP.T-S10	07-06-2013	13-08-2020		
APMP.T-S14	09-11-2016	20-02-2020		
APMP.T-S15	23-03-2017	20-06-2017		
APMP.T-S17	12-02-2019	06-09-2019		
EURAMET.T-K6.2	05-05-2017	1 st review transmitted 02-01-2018		
EURAMET.T-K8.1	05-05-2017	1 st review transmitted 02-01-2018		
EURAMET.T-S6	18-05-2016	no	15-08-2018	1 st review transmitted 15-07-2019
EURAMET.T-S7	18-07-2018	13-02-2020		
SIM.T-K6.6	2016-12-10	13-04-2017	30-09-2019	1 st review transmitted 24-02-2020
SIM.T-S6			2019-12-04	1 st review transmitted 16-07-2019
SIM.T-K9.2	07-05-2018	1 st review undergoing		
SIM.T-K9.3	17-08-2020	1 st review transmitted 30-09-2020		
SIM.T-S4			02-08-2012	2 nd review transmitted 27-07-2020
SIM.T-S6			20-04-2019	2 nd review transmitted 31-08-2020
SIM.T-S10			04-05-2020	1 st review transmitted 21-08-2020
GULFMET.T-K9	18-01-2017	21-06-2017		
GULFMET.T-S1	03-05-2017	27-08-2018		
GULFMET.T-S2	16-09-2019	1 st review transmitted 13-02-2020		
GULFMET.T-S3	16-09-2019	30-01-2020		

Silent comparisons (have not checked in with WG-KC in the past 5 years)

Comparison	Initiated	Status KCDB	Last KCDB progress report	Last contact with WG-KC	Pilot
CCT-K1.1	2006	Report in progress, Draft A	13-02-2014	Protocol approved 07-12-2006	NIST (USA)
CCT-K2.2	2012	Measurements in progress	30-01-2014	Pilot contacted 6-02-2012	INRIM (Italy)
CCT-K4.1	2012	Measurements in progress	04-02-2014	Protocol approved 12-12-2012	NMIA (Australia)
CCT-K9	2011	Measurements completed	none	Protocol approved 06-02-2012	NIST (USA)
CCT-K10	2014	Measurements in progress	22-07-2014	Protocol approved 29-09-2014	NPL (UK)
CCT-S3	2007	Report in progress, Draft A	07-02-2014	Never contacted	NMIJ (Japan)
AFRIMETS.T-S3	2012	Postponed	none	none	NMISA (South Africa)
APMP.T-K3.6	2013	Planned	none	Revised protocol approved 13-12-2013	NIM (China)
APMP.T-K4.1	2013	Planned	none	Revised protocol approved 13-12-2013	NIM (China)
APMP.T-K6.2013	2013	Planned	none	Comments on revised protocol sent 23-10-2015	MSL (New Zealand)
APMP.T-S8	2011	Measurements in progress	04-02-2012	Comments on protocol sent 02-07-2013	NMLPHIL (Philippines)
APMP.T-S11	2013	Report in Progress, Draft A	26-08-2014	Protocol approved 07-11-2013	NMIJ AIST (Japan)
APMP.T-S12	2013	Report in Progress, Draft A	26-08-2014	Protocol approved 07-11-2013	NMIJ AIST (Japan)
APMP.T-S13	2014	Planned	17-04-2014	Comments on revised protocol sent 23-10-2015	MSL (New Zealand)
COOMET.T-K6	2013	not registered in KCDB	none	Comments on protocol sent 13-12-2013	VNIIFTRI (Russia)
EURAMET.T-K3.4	2010	Report in Progress, Draft A	none	Comments on protocol send 02-05-2013	MIRS/UL-FE/LMK
EURAMET.T-K8	2008	Report in Progress, Draft A	24-04-2017	Protocol approved 13-05-2013	PTB (Germany)
EURAMET.T-K9	2014	Protocol completed	03-03-2015	Protocol approved 18-02-2015	LNE/CNAM (France)
SIM.T-S3	2007	Report in Progress, Draft B	none	Comments on report sent 20-11-2012	INEN (Ecuador)
SIM.T-S8	2014	Measurements in progress	31-10-2014	none	CESMEC (Chile)

The CCT KC/SC review process

- The comparison review process is defined by:
 - The [CIPM-MRA-D-05 document](https://www.bipm.org/utils/common/documents/CIPM-MRA/CIPM-MRA-D-05.pdf) (<https://www.bipm.org/utils/common/documents/CIPM-MRA/CIPM-MRA-D-05.pdf>)
 - CCT-specific rules
- CCT-specific rules:
 - CIPM and RMO KCs:
 - Technical Protocol must be formally approved by the WG-KC
 - Final Report must be formally approved by the WG-KC
 - RMO SCs:
 - Can be agreed, conducted and evaluated within the respective RMO
 - On request, the WG-KC reviews both Technical Protocol and Final Report

Deviations from the comparison process

- Common formal deviations:
 - Comparison not registered in the KCDB when initiated
 - Comparison status/progress not periodically up-dated in the KCDB during the course of the comparison
- use same form in both cases: *Key and supplementary comparison registration and progress form*

Deviations from the comparison process

- Common substantive deviations:
 - Technical Protocol not transmitted to the WG-KC for review in due time:
 - Transmitted after the start of the measurements
 - Transmitted when measurements are completed
 - Never transmitted
 - Technical Protocol not approved by the WG-KC:
 - Transmitted to the WG-KC, reviewed by the WG-KC, pilot received WG-KC comments but did not submit to the WG-KC a revised version for approval

→ Before starting the measurements, make sure the Technical Protocol has been formally approved by the WG-KC

WG-KC position/recommendations with respect to comparisons deviating from the process

- WG-KC strongly discourages consulting the WG-KC only at the later stages of a comparison
- Nevertheless, if the comparison and the reporting are technically valid, the WG-KC will approve the report, irrespective of its compliance with the formal process
- WG-KC proposes that, at the time pilots register a comparison in the KCDB, they receive the two check lists prepared by the WG-KC to help pilots prepare the technical protocol and the report (the two check lists will be posted in the BIPM site)
- WG-KC recommends the RMO TC-T chairs prescreen protocols and reports of RMO KC/SCs before transmitting them to the WG-KC

List of headings to guide the comparison pilots in preparing the Technical Protocol (1/2)

"Acronym (CCT-KX, RMO.T-KX.Y, RMO.T-SX)"

Comparison of ...

Technical Protocol

Main authors and affiliations

Date:

Version:

1. Introduction

- Initiator of the comparison
- Objectives, quantity and range of the comparison
- Reference documents followed in drawing the technical protocol

2 Participants:

- List of participant laboratories (contact persons, their mailing and electronic addresses can be placed in a separate appendix)
- Roles (coordinating group preparing the technical protocol, pilot(s), co-pilot(s), sub-pilot(s), ...)

3 Comparison methodology

- Topology of the comparison (loops, circulation scheme, ...)
- Starting date and detailed timetable

4. Travelling standard(s)

- Detailed description of the device(s) (make, type, serial number, size, weight, packaging, ... and technical data needed for its operation)
- Advice on handling the travelling standard(s), including unpacking, subsequent packing and shipping to the next participant
- Tests to be carried out on the travelling standard(s) upon receipt before measurement
- Conditions of use of travelling standard(s) during measurement
- Final tests before packaging the travelling standard(s) and ship it to the next laboratory
- Procedure in the case of failure of the travelling standard(s)

List of headings to guide the comparison pilots in preparing the Technical Protocol (2/2)

5. Organizational aspects

- Procedure in the case of unexpected delay at participating institute
- Customs formalities and documents to accompany the travelling standard(s) (ATA carnet or others)
- Financial aspects: responsibility for travelling standard(s) costs, transport costs, customs charges, damage costs
- Insurance on travelling standard(s)

6. Communication flows

- From participant to pilot: informing the pilot of the arrival of the travelling standard(s)
- From participant to pilot: communicating measurement delays to the pilot
- From participant to participant informing the next participant when shipping the travelling standard(s)
- From participant to pilot: communicating the measurement results to the pilot
- Due dates and consequences when failing to comply with due dates

7. Measurement instructions and procedures

- Measurement instructions (state if there are any specific instructions)
- Measurement procedures (state if there are any specific procedures)

8. Reporting the results

- Instructions for reporting the results of tests carried out on the travelling standard(s) upon receipt before measurement
- Instructions for reporting the measurement results (Excel[®] sheet)
- Instructions for reporting the uncertainties (Excel[®] sheet)
- Instructions for reporting additional information

9. KCRV and Linkage mechanism

- For CIPM KCs: method for calculating the KCRV and its uncertainty
- For RMO KCs: method for linking to the KCRV of the parent CIPM KC

10. Document revision history

List of headings to guide the comparison pilots in preparing the Final Report (1/2)

"Acronym (CCT-KX, RMO.T-KX.Y, RMO.T-SX)"

Comparison of ...

Report (Draft A)

Authors

Date:

Version:

1. Introduction

- Objectives, quantity and range of the comparison
- Short history of the comparison (the comparison was initiated on..., the protocol was approved on..., the measurements were performed between... and..., ...)

2 Participants:

- List of participant laboratories (contact persons, their mailing and electronic addresses can be placed in a separate appendix)
- Roles (coordinating group preparing the technical protocol, pilot(s), co-pilot(s), sub-pilot(s), ...)

3 Comparison Pattern

- Topology of the comparison (loops, circulation scheme, ...)

4. Travelling standard(s)

- detailed description of the device(s) (make, type, serial number, size, weight, packaging, ... and technical data needed for its operation)

List of headings to guide the comparison pilots in preparing the Final Report (2/2)

5. Equipment and measuring conditions at participating laboratories

- Specific measurement instructions or procedures (if any)
- Detailed description of equipment and measuring conditions at participating laboratories

6. Measurement results

- Measurement results at each participating laboratory, including uncertainty of each participating laboratory (the full uncertainty budgets must be reported but can be placed in a separate appendix)

7. Analysis of the results

- Determination of the bilateral equivalence between the participating laboratories (for all comparisons)
- Determination of the KCRV (only for CIPM KCs) and its uncertainty
- Determination of the DoE's (for CIPM KCs and RMO KCs the DoE's must be explicitly reported)
- Linkage to the parent CIPM KC (for RMO KCs)

8. Conclusions

- Concluding remarks (were the objectives achieved?)
- Lessons learned: recommendations for future comparisons

9. Appendices

- Approved protocol
- Document control history (changes applied to the report to address reviewers' comments, ...)

CCT document on sealed metal fixed point cells

- During last WG-KC meeting (Chengdu 2019) we agreed that:
 - The visibility of the document in the website should be improved (*“Publications”* → *“Guide to the realization of the ITS-90”* → *“Metal fixed points for contact thermometry”* → *Go to page 2* → *Appendix 1*)
 - The document should be revised to emphasize the character of **minimum achievable values** of the standard uncertainties recommended by the document
- As the document currently falls under the domain of the WG-CTh, the WG-CTh chair was contacted
- The WG-CTh chair proposed to:
 - Remove the document from the section “Guide to the realization of the ITS-90”
 - Place it in the section “Guide on Secondary Thermometry”, possibly under “Specialized fixed points above 0 °C”

CCT document on sealed metal fixed point cells

- Position 1:
 - Move it from the “Guide to the Realization of the ITS-90” to the “Guide on Secondary Thermometry”
 - Have the TG-G-o-TH revise the document and place it as a section of “Specialized fixed points above 0 °C” (under “Guide on Sec. Therm.”)
- Position 2:
 - Keep it in the “Guide to the Realization of the ITS-90”
 - Avoid separation between open cells (in the “Guide to the Realization of the ITS-90”) and sealed cells in the “Guide on Secondary Thermometry”
 - Recognize that, *de facto*, many NMIs regard sealed cells as their primary realization of the ITS-90

CCT document on sealed metal fixed point cells

- Need CCT position on the status of the ITS-90 realization with sealed cells because of the significant consequences in technical assessments and CMCs
- Many NMIs rely only on sealed cells for their ITS-90 realization
- Are they independently realizing the ITS-90?
- Do they have to get traceability for their sealed cells from other NMIs?

Need of future KCs

- On request of the WG-Hu chair, the need of a new K6 was discussed:
 - All members regarded a new K6 as necessary because CCT-K6 is obsolete (many standards used in CCT-K6 have been replaced and do not longer exist so existing CMCs are unsupported)
 - Some members expressed their concerns for the required workload and proposed a limited and strategic selection of the experimental points
 - All members agreed that, before starting a new K6, all humidity KCs should be finalized

New types of KCs testing thermodynamic T

- It was general opinion that it is still premature to consider KCs testing thermodynamic temperature
- Some speculations:
 - Appropriate travelling standards will be needed
 - Travelling standards would be ITS-90 devices (SPRTs or fixed point cells)
 - Concerns about required workload
 - Use $T - T_{90}$ to support T dissemination

Analysis of key comparison results

➤ Many approaches:

- Cox 2002 *Metrologia* **39** 589-95 → Recipe-based (prescriptive, step-by-step)
- White 2004 *Metrologia* **41** 122-131 → Model-based + constrained least squares
- Cox 2007 *Metrologia* **44** 187-200 → Model-based (Common Mean) + largest consistent subset
- Koepke et al. 2017 *Metrologia* **54** S34-S62
 - Model-based (Random Effects) + DerSimonian Laird
 - Model-based (Random Effects) + Hierarchical Bayesian
 - Model-based (Random Effects) + Linear Pool
- Molloy et al. 2020, submitted to *Metrologia*

} NIST Consensus Builder

➤ Do we need a CCT document giving a common framework on the approach to the analysis of KCs?

THANK YOU

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