

Minutes of CCT-TG-Dig meeting on 3 April 2023

13:30 – 15:30, Disneyland Hotel, Anaheim, California, USA

Final version

Attending:

- Christof Gaiser (PTB, Germany) [“CG”]
- Roberto Gavioso (INRiM, Italy) [“RG”]
- Yasuki Kawamura (AIST/NMIJ, Japan) [“YK”]
- Graham Machin (NPL, UK) [“GM”]
- Ingmar Muller (PTB, Germany) [“IM”]
- Bethany Rodman (NIST, USA) [“BR”]
- Patrick Rourke (TG Chairperson, NRC, Canada) [“PR”]
- Mohamed Sadli (LNE-Cnam, France) [“MS”]
- Peter Saunders (MSL, New Zealand) [“PS”]
- Inseok Yang (KRISS, South Korea) [“IY”]

Not attending:

- Jintao Zhang (NIM, China) [“JZ”]

Action Items

1. PR to make updated *MeP-K* draft as per the TG decisions made at this meeting & circulate it to the TG. [Section II.2]
2. PR will request that BIPM issues DOIs for the ITS-90 and PLTS-2000 definition documents. [Section II.4]
3. GM will ask Stephanie Bell if there is someone from CCT-WG-Humidity who could join TG-Dig to bring humidity expertise. [Section II.6]
4. PR will ask Jovan Bojkovski if there is someone from CCT-WG-CMC who could join TG-Dig to bring CMC expertise. [Section II.6]
5. PR to e-mail slides to all TG members. [Section III]

I: Past: The first year of TG-Dig

1.1. Review the formation & initial Terms of Reference of the Task Group and 1.2. What have we accomplished?

PR reviewed the formation & initial ToR of the TG, and what has been accomplished in the first year.

1.3. How much progress has BIPM made on activities related to our TG? and 1.4. CIPM Meeting March 2023

PR also reviewed progress made by the BIPM related to our TG, & CIPM digital-related decisions from their March 2023 meeting.

II. Present: The second year of TG-Dig

II.1. Poster at ITS10

PR mentioned that TG-Dig ITS10 poster is printed and ready to present this week.

II.2 Digitization of the MeP-K

GM explained that WG-SP envisioned the next major *MeP-K* content update not happening until 2027 (e.g. adding new techniques), to provide stability to the community.

II.2.a Naming of the document

The TG agreed that the "Digitalized" version of the *MeP-K* should have a name like *MeP-K-19D*, not *MeP-K-23*, since it is not a full new version.

II.2.b Convert all hyperlinks, annexes, *etc.* into numbered references; further structuring guidelines from Janet Miles (BIPM)

The TG agreed to PR's restructuring changes.

II.2.c Add direct references to all final contributing Boltzmann constant papers

The TG agreed to NOT add *k* papers to the *MeP-K* at this time.

II.2.d Add mention of & reference to the BTM guides

The TG agreed to NOT add BTM guides to the *MeP-K* at this time.

II.2.e Replace the reference to the CCT $T-T_{90}$ document with a reference to a new (not yet created) CCT $T-T_{\text{scale}}$ document that will cover the most recent WG-CTh $T-T_{90}$ consensus estimate, radiation thermometry $T-T_{90}$ from Peter's paper, and most recent knowledge of $T-T_{2000}$ and II.2.f Add specific mention of Jost Engerts's latest $T-T_{2000}$ work

CG said Jost's new $T-T_{2000}$ new data is not yet done. The TG agreed to NOT add any specific mention of new $T-T_{2000}$ work to the *MeP-K*. $T-T_{2000}$ information will similarly NOT be added to the new CCT $T-T_{\text{scale}}$

document (beyond perhaps a footnote), so this new document will remain $T-T_{90}$ and can still be referred to as such in the *MeP-K*. CG will make a 1st draft of the new CCT $T-T_{90}$ document and circulate it to WG-CTh, then afterwards to WG-NCTh in consideration of adding radiation thermometry $T-T_{90}$. This will happen independently of TG-Dig, and will simply replace the existing $T-T_{90}$ reference in the *MeP-K*.

II.2.g Add reference to the big forthcoming *ab initio* thermophysical properties paper

RG related that the big forthcoming *ab initio* paper will be submitted to *JPCRD* by the end of April. The TG agreed that this new *ab initio* paper should be added as a reference in the *MeP-K*.

II.2.h Similarly, add reference to the 2021 RIGT paper, which supersedes parts of the 2019 RIGT review article as best practices for kelvin realization by refractive index techniques

The TG agreed that the 2021 RIGT paper should also be added as a reference in the *MeP-K*.

II.2.i Replace “placeholder” Qu *et al.* and Flowers-Jacobs *et al.* JNT references with a reference to the 2019 *MST* Johnson Noise Thermometry review article

The TG agreed that the Qu & Flowers-Jacobs JNT references in the *MeP-K* should be replaced by the Qu 2019 *MST* review article & the new review article by Rod White everywhere.

II.2.j Add a reference to the official ITS-90 text on the BIPM website, alongside the existing Preston-Thomas *Metrologia* article, because it is open access

The TG agreed to swap the official ITS-90 text from the BIPM website IN PLACE of the existing *Metrologia* article.

GM suggested that the "D" version of the *MeP-K* include a short paragraph of text at the top to say exactly which references we added/changed, and that this was to reflect the latest best practices for realization of the kelvin. This suggestion was agreed to by the TG.

IM mentioned that one option would be to say that the original non-machine-readable *MeP-K* was the "official" valid version, but have a separate newer machine-readable digitized *MeP-K* version. Other TG members said it would be confusing to have two versions that were not the same, since machines looking at one version and humans looking at the other version might then realize the unit differently from each other.

II.2.k Go through PR & GM's individual comments / questions in the tracked-changes Microsoft Word draft

Individual comments by PR & GM were mostly already covered above, or made irrelevant by the above TG decisions.

II.2.l Other issues to discuss here? Hand-off to WG-Cth & WG-NCTh?

TG agreed that after TG has settled on a final draft, it will be moved to WG-CTh & WG-NCTh for further discussion.

II.2 Action items:

- PR to make updated *MeP-K* draft as per the TG decisions made at this meeting & circulate it to the TG.

II.3 Extracting data from CCT documents

II.3.i Interaction with BIPM?

The TG agreed that if/when BIPM staff have questions or need clarification of data we extracted, it should go first to the TG member in charge of digitizing that particular document.

II.3.ii Which documents to do & timeline?

II.3.ii.a New combined $T-T_{\text{scale}}$ CCT document; II.3.ii.b Big multi-author *ab initio* thermophysical properties paper; II.3.ii.c 2021 RIGT *JPCRD* review paper; II.3.ii.d Original 2019 RIGT review article; II.3.ii.e Primary JNT annex; and II.3.ii.f 2019 JNT *MST* review article

The TG agreed that data should be extracted from those documents, once they are ready/published. The TG agreed that the digitization order should be b) before c) before d), and e) before f), because we do not need to digitize the parts of the older papers that are superseded by newer papers, so we should digitalize newer papers first.

II.3.ii.g *Guide to the Realization of the ITS-90*; II.3.ii.h Any of the *Guides to Secondary Thermometry*; II.3.ii.i *Body Temperature Measurements Best Practices Guides*; and II.3.ii.j Other things

The TG agreed that, at least for now, we should not extract data from the *Guides*. These would be a lot of work to do, and the BIPM has not started building APIs out of the data we have already extracted from other documents. So we should wait to see the BIPM outcome of what we have done so far before considering whether digitalizing the *Guides* would be helpful enough to the community to justify the effort.

IM noted that AI technology is rising, and in the future AI might be employed to do the first data extraction step, with humans as secondary checkers; so we should not put too much effort into the data extraction right now.

MS suggested, and the TG agreed, that we should recommend to the BIPM that the data we have extracted be converted not only to APIs, but also to embedded web apps, that people can access through a web browser (not only direct machine calls to server APIs). For example, from the $T-T_{90}$ document, a web app could allow entry of T_{90} and it would give the corresponding T .

II.4 Document indexing & archiving approach: BIPM issues DOIs; CCT manages version # & date, archiving of old versions, changelog for each document

TG members were disappointed that, beyond issuing DOIs, the BIPM will not help implement an indexing and archiving approach for CCT documents, but rather this would have to fall upon the CCT. The TG members also commented about the updated BIPM website, and how hard it is to find documents there.

The TG agreed that it was not feasible to go back and index old versions of documents. But rather the TG can discuss & make a recommendation to the CCT in terms of a unified approach to indexing and archiving new documents and new versions of documents in the future.

MS asked whether the issuing of DOIs by the BIPM would make those documents more findable and how the BIPM would decide what to issue DOIs for and when new versions needed new DOIs. PR replied that his understanding is that this TG would request DOIs for particular documents/versions, to be agreed by the TG: the BIPM would not issue DOIs on their own initiative. PR expressed the hope that if a particular document had a DOI issued by the BIPM, then if the BIPM changed the web address of that document, they would make sure the DOI pointed to the new web address, which could help reduce *e.g.* orphaned links in publications that cite CCT documents.

The TG agreed to request DOIs for the ITS-90 and PLTS-2000 definition documents.

II.4 Action items:

- PR will request that BIPM issues DOIs for the ITS-90 and PLTS-2000 definition documents.

II.5 Test BIPM APIs?

BIPM has not yet implemented any APIs from the data TG-Dig members extracted, so there is no testing to do yet.

II.6 Possible “gentle” volunteer-based scope expansion in TG’s 2nd year?

II.6.i. Support BIPM CMC digitalization/FAIR efforts? “On call” advisors

In terms of on-call advisors to the BIPM for questions related to CMC digitalization, Patrick volunteered. Need at least one other person with expertise in humidity, and someone with expertise in CMCs.

II.6.ii Other suggestions?

There were no other suggestions.

II.6 Action items

- GM will ask Stephanie Bell if there is someone from CCT-WG-Humidity who could join TG-Dig to bring humidity expertise.
- PR will ask Jovan Bojkovski if there is someone from CCT-WG-CMC who could join TG-Dig to bring CMC expertise.

II.7 Discuss & prepare possible recommendations from the TG to the CCT

At this point, there are not any recommendations to make to the CCT. It is possible that the TG will have a recommendation regarding an indexing and archiving approach during the coming year.

III. Future: Wide-ranging discussion about the future of TG-Dig beyond the 2024 CCT meeting

III.1 I aim for us to complete our existing tasks in the coming year. Should we then ask the CCT in 2024 to renew/recreate the TG for another term? and III.2 If yes, what might we propose for our new scope & ToR? What activities should we undertake that would be actually helpful to someone?

TG members generally agreed that extending the TG beyond the 2024 CCT meeting was probably justified. GM cautioned that we should not make enormous scope, just focus on the few things that we can meaningfully contribute to.

III.3 Continue beta testing / interfacing with BIPM staff, since they will not be done building the APIs from our data within the next year

GM noted that since the TG was formed to support the BIPM Digital SI efforts, if BIPM staff have not progressed in using the data we have already extracted, then we could suspend the TG until it is needed again.

III.4 General "on call" advisory role to BIPM as they move through digitalization work

TG members agreed it is a good idea to generally emphasize & formalize the advisory role of the TG, rather than the direct tasks of e.g. extracting data.

III.5 Advise BIPM on unique measurand names (taxons) & corresponding definitions, for standardized metrology taxonomy to flow from KCDB to QI to DCCs etc.

IM suggested that the TG focus on tasks that have the largest impact & biggest visibility, especially "how do you name things?"

III.6 More KCDB stuff: which service categories are particular DIs designated for? CMCs are supported by which comparisons?

The TG agreed that specific TG tasks in this area are not justified, but something related might fall under the general advisory role from III.4.

III.7 Is there a need to extract data from CCT KC reports (big job)?

The TG agreed that there is no need to extract data from CCT KC reports.

III.8 Study & compare different uncertainty calculator codes (e.g. GTC vs METAS one vs NIST one), make a recommendation to CCT/BIPM/whoever about what is best

IM mentioned that it would be useful if there was a website where a user could enter input and then get results from all 3 codes, but that directly testing codes was outside of his experience. The TG agreed that such a study would be too big, and not suited to the skills & range of expertise of the TG members.

III.9 Develop best practices guides for temperature-related digitalization

IY thought that TG-Dig can have a role in giving advice to DCC people. For example, how a computer can call ITS-90 coefficients to convert calibration data to calibration coefficients, or what entries should be in a DCC. The CCT could issue guidance for what should be in thermometry DCCs, including organizations using & issuing DCCs outside of NMIs.

III.10 In-situ traceability, self-calibrating sensors, etc.? Creation of a different TG?

GM discussed the digital aspects of a large sensor network in which a few of the sensors were self-calibrating. PR emphasized that while digital technologies are important tools, the fundamental issues of MRA, equivalence/comparability, etc. of self-calibrating sensors run deeper than this and are not related to digital. The TG agreed that a separate TG should be created for this, it should not be taken on as part of TG-Dig. MS suggested that such a new TG should also fold in external users beyond the CCT.

III.11 Other suggestions?

IM suggested making sure that the thermometry part is seen in other groups' discussions of digital measuring systems in general -- how do we validate them, networks, metrology cloud, etc.

MS suggested conducting a survey of existing DCCs.

CG said that in the long term, DCCs are an important area, but the key issues might be higher than the CCT.

MS is part of a EURAMET TG discussing DCCs and can act as a liaison between that group and TG-Dig.

GM suggested that if TG-Dig begins to focus on DCCs, it will need different members, who have DCC expertise.

RG raised the idea that if the TG is to become mostly advisory and continue work in the long term, it could be better suited as a WG rather than a TG.

MS mentioned that he will be attending a conference in the South of France in June about metrology and data, and would like to make a presentation there about TG-Dig. The TG agreed to this. PR encouraged other TG members to do similar outreach as well, but just keep the TG informed.

RG requested a copy of the discussion slides from the current TG meeting.

III Action items:

- PR to e-mail slides to all TG members.