Problems for the KCDB concerning the updating of published results to take posterior information into account

(the case of isotopic systematic effect in thermal metrology)

F.Pavese

IMGC, Torino, Italy

NMIJ-BIPM 2005, Tsukuba, Japan

Satellite Workshop on Key Comparison Data Evaluation

KCDB Appendix B: main advantages

- Complete and comprehensive record of the state-of-the-art of current National standards
- Transparent and uniform treatment, with un-ambiguous identification of the measurand of **key comparisons**
- Record of MRA international equivalence
- Historical tracking of the above features

KCDB Appendix B: key comparisons

- What a KC is <u>not</u> supposed to be:
  - A proficiency test
  - An extra-ordinary excercise
- What a KC is supposed to be:
  - A scientific excercise supporting the **current** capability of each participating NMI in the everyday typical realisation of a given SI standard at a given time

    (e.g., for temperature the ITS-90)

MRA Key comparisons: consequences

- No random selection of the participating NMIs *(MRA rule)*
- No standard method, only best practice of each NMI
- (Implicit) assumption that each sample drawn from the local standard –input data of the KC– represents the local population *(not only the KC local sample)*
- The supplied local **value** is a representative value of the local population *(not of the KC local sample)*
- The estimated local **uncertainty** is relative to the local capability of realising the given standard –normal, though the best *(not to the KC local sample)*

(for details see Poster presentation)

KCDB & Key comparisons: a trade-off

- On one hand, the KCDB should provide
  - State-of-the-art at a given time

  (but, not only the capability during the KC)
- On another hand, the KCDB should
  - avoid "freezing" possible errors in a particular KC and/or NMI
  - track in time either improvement/degradation of capabilities, new knowledge
- *(experience has shown that the next KC can be 10 years far away)*

A case: isotopic problems in thermal metrology -1

- **Neon**: effects on T_{tp} and *vp* known since '70s, but no evidence of actual isotopic composition variability in commercial gases until 2003 *(publication in 2005)*
- **Water**: possible effects in IPTS-68, but known since 1996 and quantified in 2002
- **Hydrogen**: known in thermometry since 1999, comprehensive study on T_{tp} published in 2005 (experimental data on *vp* not available yet)

(the problem is sample-to-sample isotopic variability)

A case: isotopic problems in thermal metrology -2

- **Consequences**: past KCs suffered from lack of knowledge on these effects at the time they were performed:
  - K1 (< 24,5 K) hydrogen, neon
  - K2 (13,8 to 273,16 K) hydrogen, neon
  - K3 (84 K to 630 °C) water
  - K7 (tp water, Kelvin definition) water

  (no information presently available of possible effects in metal fp)
- **Knowledge advancement is progressive**

KCDB & Key comparisons: a trade-off
Present tool *(apart from a new KC) -1*

Bilateral KC

- Does it have the same statistical status of the corresponding CIPM KC ?
  - ✓Single linking NMI

    (MRA requires more than one $\Rightarrow$ at least tri-lateral?)
  - ✓Quality of the linking NMI(s)

    (same if NMI(s) had low vs large uncertainty at the CIPM KC?)
  - ✓Linking problems outside simple cases

KCDB & Key comparisons: a trade-off
Present tool *(apart from a new KC) -2*

Bilateral KCs cannot be

- a route to circumvent CIPM or multilateral KCs
- the (only) way to fix errors identified in past KCs
- a way to track progress/regression in local capabilities in times subsequent to a KC
- a way to take new knowledge into account

KCDB & Key comparisons: a trade-off

New needed tools *(apart from a new KC)*

... on existing data published on the KCDB,

1. to apply corrections to newly identified systematic effects in a category of standards
2. to take corrective actions on later identified errors in local standards
3. to support CMC (Appendix C) revision, especially toward lower uncertainties

New tools for the KCDB Appendix B: *suggestions -1*

1. To apply correction to newly identified systematic effects in a **category of standards**:

   - **Allow re-publication of corrected/updated KC data, DoEs and uncertainties** (under a minimum set of requirements)**: on input of CCs**
   - **Log history of the KC** (old versions, changes made, … *–with methods similar to the ones for software version-tracking*)

New tools for the KCDB Appendix B: *suggestions -2*

2. To take corrective actions on later identified errors in **local standards**:

• **Log new evidence from each NMI:** auxiliary files* clustered/linked (+ RMOs, bilaterals, …) to the main KC page

***** *on NMI responsibility, but supported by a minimum set of requirements and under CC authorisation (MRA:* "publishing regular reports on the work of their laboratories and transmitting them to the BIPM")

• **Allow re-publication of updated KC data, DoEs and uncertainties,** when the CC requires to adjourn or "step forward" the KC

New tools for the KCDB Appendix B: *suggestions -3*

3. To support CMC (Appendix C)* revision, especially toward lower uncertainties:
   - **Allow re-publication of corrected/updated KC data, DoEs and uncertainties arising from new/improved knowledge**
   - **Allow re-publication of updated KC data, DoEs and uncertainties,** when the CC requires to "step forward" the KC or the related CMCs
   - **Set minimum criteria**, including consensus threshold uncertainty values, to be endorsed also by regional accreditation bodies

** CMC should mainly be based on the technical-scientific evidence provided by the data contained in Appendix B.*

Conclusions

- The present KCDB is making a great job in collecting the state-of-the-art of metrology standards in a uniform and comprehensive way
- Experience gained so far suggests to base further progress **not** only on new CIPM KCs
- Other types of KCs, in particular the bilateral, should remain only second-tier
- New additional tools are suggested, adding flexibility while keeping rigor to the published information concerning the CIPM KCs
- Some may require limited MRA adjustments.

A new tools for the metrology worldwide Community

IMEKO Technical Committee **TC21**

“Mathematical Tools for Measurements”

Chairman: F.Pavese, IMGC, Italy

Scientific Secretary: A.B.Forbes, NPL, UK

www.imeko-tc21.org

www.imeko.org

www.amctm.org

now looking for more non-EU members

Scope of IMEKO TC21

To promote the harmonisation, the co-ordinated use and the development of new mathematical and statistical tools for measurements, and their implementation in guides, procedures and codes, acting as a portal on an international environment.

Aims of IMEKO TC21

To help advancement

- in research, to bridge the gap between scientists working in the fields of measurement science, metrology, testing, applied mathematics, statistics, databases and IT, allowing better and more efficient tools to be developed for specific purposes. The activities should involve the synergy of specialists in all relevant fields;

- in production and services, by allowing a more efficient transfer of research results to the users in enterprises and a better knowledge of the needs of the enterprises on the relevant issues. The principal scope should be getting more value from the measurements, particularly for the benefit of measurement equipment manufacturers and users who use extensively computational tools;

- in supplementing other IMEKO TCs with a focused viewpoint and activities concerning the development of specific tools in the relevant fields of the scope.