Meeting of the CCM Task Group on the Phases for the Dissemination of the kilogram following redefinition

(CCM-TGPfD-kg)

24th Jan 2019, BIPM

Meeting conclusions and outstanding issues (in green)

The initial determination of the consensus value

Following the completion of the first CCM Key Comparison of realisation experiments the consensus value for the kilogram will be adopted. The value will be physically maintained by the BIPM who will provide traceability for national standard kilograms. The consensus value will be calculated based on three sets of data;

1. the value of the IPK (taking into account the additional uncertainty of 10 micrograms and a contribution for the temporal stability of the weight).
2. extant data from the CCM Pilot Study of realisation experiments
3. the results of the first CCM Key Comparison

Each data set will be given the same weight in the calculation of the consensus value. Note that data sets 1. and 2. are both linked to the IPK since the Pilot study was completed prior to CODATA fixing the value of the Planck constant. The calculation of the initial consensus value will therefore be weighted 66.6% to the extant value of the IPK, thus ensuring continuity of the value of the kilogram.

The temporal evolution of the consensus value

On completion of subsequent Key Comparisons the value of the consensus value will be calculated from the three most recent data sets, thus limiting temporal changes in the consensus value.

The uncertainty of the consensus value

The standard uncertainty in the consensus value will be ± 20 µg. This value was decided selected? by the CCM Task group on the Phases for the Dissemination of the kilogram following redefinition (CCM TGPfD-kg) and was arrived at based on;

- Typical uncertainty of “mature” realisation experiments such as those at NIST, NMIJ, NRC and PTB
- The target uncertainty of newer realisation experiments which are predicted to be completed in the next 10 to 20 years
- An assessment of the likely stability of the IPK over a period of 20 years (this period being an estimate of the maximum time for which it will be necessary to use the consensus value)

(*Here we can add arguments against lower (std dev of the mean) or higher (std dev of pooled data) uncertainty values)*

In considering the uncertainty assigned to the consensus value, readers are reminded that use of a consensus value during the process of transition from the IPK to individual realisations was driven by the need to address the inconsistency in the results of the realisation experiments and not a desire to reduce the uncertainty in the realisation.

Effect on current published CMCs

Phase 1

For the period of the dissemination process following the redefinition on 20 May 2019, during which traceability continues to be taken from the IPK, an additional uncertainty coming from the new definition (± 10 µg) will need to be added to the uncertainty of the IPK and therefore also to all kilogram standards (included those which were calibrated by the BIPM before 20 May 2019).

Prior to the implementation of Phase 1 of the dissemination process, laboratories with published CMCs should review, and if necessary update, their CMCs taking into account this additional uncertainty component. This will result in a maximum increase of about 22% in the CMC values currently in the KCDB (only five laboratories are affected at this level).

During Phase 1 of the dissemination process the BIPM will not undertake calibrations for NMIs since they will be occupied piloting the first Key Comparison of realisation experiments. Once the initial Key Comparison has been completed and the consensus value has been agreed, the BIPM will again be able to provide calibrations for NMIs, traceable to the consensus value (see below).

Phase 2

On completion of the first Key Comparison of realisation experiments and the implementation of the consensus value (Phase 2) laboratories with published CMCs should review, and if necessary update, their CMCs taking into account the additional uncertainty coming from the new traceability to the consensus value (± 20 µg).

The BIPM will be responsible for the practical maintenance and dissemination of the consensus value. It is likely that the BIPM will be able to disseminate the consensus value to platinum-iridium or stainless steel weights at a level of uncertainty of close to the uncertainty in the consensus value (± 20 µg). Thus, by eliminating the need for NMIs to make significant air buoyancy corrections, the increase in uncertainty from maintenance and dissemination at the NMIs will be minimised and CMCs at the level of ± 22 µg should be achievable.

Criteria for transition from Phase 2 to Phase 3 of the dissemination process

- A minimum of five consistent realisation experiments which;
    - Declare Key Comparison results with a relative standard uncertainty of 40 ppb or better
    - Demonstrate equivalence with the KCRV
    - Demonstrate stability by producing consistent (equivalent) results for two consecutive Key Comparisons
- The consistent set of experiments must include two independent methods of realising the SI unit of mass (e.g. Kibble balance and X-ray crystal density experiments)

Traceability in Phase 3 of the dissemination process

Once the criteria for the transition from Phase 2 to Phase 3 of the dissemination process have been met the realisation experiments which have fulfilled the criteria will be able to publish CMCs, validated by the results of the Key Comparisons, and will be able to provide traceability to other NMIs based on these CMCs. Additionally the BIPM will continue to provide calibrations for NMIs but traceability will not be to the consensus value but to the validated realisation experiments via the

results of the Key Comparison or to the BIPM Kibble balance experiment once it reaches a suitable level of uncertainty and has been validated as described above.

(*We need to decide what uncertainty BIPM should use for the continuation of traceability during Phase 3). Clearly the uncertainty in the KCRV will be unacceptable, I suggest we carry on using the unc. In the consensus value?)*