Brief guidelines for linking RMO key comparisons to the CIPM KCRV

1.   Some guidelines are available to aid the evaluation of CIPM key comparison data and produce a key comparison reference value (KCRV) [1]. When an RMO runs a key comparison, it is with a view to linking it to the parent CIPM comparison, which may be a CC or a BIPM comparison, and thus extend the degrees of equivalence with the KCRV to other NMIs in the region.

2.   A number of linked comparisons have already been published in the KCDB using different methods [2 – 4]. Brief guidelines are presented here simply to clarify some aspects of linking comparisons while leaving each CC to determine the method best suited to its measurements.

3.   An RMO key comparison cannot have a separate key comparison reference value but all of its results are linked to the KCRV of the CIPM comparison. The RMO may also choose to make a "regional mean" or reference value for the RMO report if it wishes, but this is not a KCRV and cannot be used in the KCDB. In some circumstances, it may be used to facilitate the link between the two comparisons [5].

4.   An RMO key comparison must have at least one participant that has already taken part in the CIPM comparison and preferably more than one to make sure that the link to the KCRV is robust [6]. Note: The period since participation in the CIPM comparison should not exceed that recommended by the CC to ensure the stability of standards.

5.   A simple link to the KCRV may be made using, for each linking laboratory, the ratio of the results obtained in the CIPM and RMO comparisons. If this ratio is very similar for the different linking laboratories, the arithmetic mean may be used as the linking factor. This for N linking laboratories, the linking factor (or coefficient if the units are not the same in both comparisons) is

$$\frac{1}{N}\sum_{L=1}^{N}\frac{C_L}{R_L}$$

where C_L is the result for linking laboratory L in the CIPM comparison and R_L is the result in the RMO comparison. Alternatively, the CC may decide to select a reduced set of laboratories for the link, use a weighted mean or another method. Each of the other results in the RMO comparison can then be normalized using the appropriate linking value. Note: Although the RMO may publish a report of its comparison, linked results can only be published after approval by the CC.

6.   Any normalization using a linking value should produce a result that can be displayed with the same units and in the same graph and matrix as the CIPM comparison. Note: The linking laboratories normally stay in the original relevant CIPM part of the graph and matrix of equivalence and do not appear twice. However, the results of the linking laboratories in the RMO comparison are normally given in the Final Report and used to indicate the degree of consistency with their measurements in the CIPM comparison [7].

7.   Those linking laboratories that have contributed to the KCRV in the CIPM comparison will already have correlations to the KCRV and perhaps also to each other

that have already been taken into account. The other regional participants will have correlations in the degrees of equivalence with the linking laboratories that should also be taken into account as well as correlations between each other related to the travelling standard and perhaps their measurement methods.

8. Some national laboratories in the RMO comparison may only hold secondary standards. In this case, they will have correlations that need to be taken into account for the degrees of equivalence with the primary laboratory (in another country) to which they are traceable, and also to any other laboratories traceable to the same primary laboratory.

9. As an example of a more complete linking method, an analysis method based on linear generalized least-squares estimation has been developed [8] to give the degrees of equivalence directly between two or more linked comparisons. This method also takes into account multiple travelling standards (including any instabilities), multiple measurements by any given laboratory, multiple comparison loops and the correlations between measurements.

10. The CC is the final arbiter of the method and values used to link key comparisons.

References

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