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### **Technical protocol for a BIPM ongoing key comparison in dosimetry**

This short technical protocol produced by the BIPM specifies in general the procedure to be followed for the particular dosimetry comparison. Details about the BIPM dosimetry standards, the reference conditions for the comparison and the BIPM uncertainty budgets, agreed and approved by the CCRI, are given in [1].

It is important to remember, however, that the purpose of a key comparison is to compare the standards as realized in the participating institutes, not to require each participant to adopt precisely the same conditions of realization [2]. The protocol, therefore, specifies the procedures necessary for the comparison, but not the procedures used for the realization of the national standards being compared.

This protocol covers the general procedure for the key comparisons, BIPM.RI(I)-K1, BIPM.RI(I)-K2, BIPM.RI(I)-K3, BIPM.RI(I)-K4, BIPM.RI(I)-K5, BIPM.RI(I)-K6, BIPM.RI(I)-K7 and BIPM.RI(I)-K9. The key comparison BIPM.RI(I)-K8 has a separate protocol as it presently uses BIPM transfer instruments at the NMI site.

The comparison results are published in the Key Comparison Database, KCDB [3]. The comparison reports are published in the journal “Metrologia”, accessible from the KCDB.

The comparisons can be done directly using the primary standard and/or indirectly using transfer standards, preferably two or three instruments. While the use of transfer standards might introduce more uncertainty in the comparison results than for a direct comparison of the primary standards, useful information is gained on the NMI calibration capabilities, reproducibility of calibration coefficients, dissemination and traceability.

The comparisons, BIPM.RI(I)-K1, BIPM.RI(I)-K2 and BIPM.RI(I)-K5 can be made using the NMI primary standards; BIPM.RI(I)-K3, BIPM.RI(I)-K4, BIPM.RI(I)-K6, BIPM.RI(I)-K7 and BIPM.RI(I)-K9 are normally made using transfer standards. Note that for BIPM.RI(I)-K4 and BIPM.RI(I)-K6, the NMI instrument to be used must be waterproofed, either by itself or by using a waterproof holder; for BIPM.RI(I)-K9, only water-proof chambers can be used.

A representative of the NMI can hand-carry the standard and be present during the comparison to oversee the safe handling of the instrument and monitor the measurements. If the standard is sent unaccompanied to the BIPM, advice on its handling, including unpacking and subsequent packing and return shipping to the participating institute should be provided; this should include a complete list of the contents of the package and the weight and size of the whole package.

The measurements for each comparison at the BIPM can normally be made over five working days. In some cases, comparisons can be run in parallel but confirmation of this is needed prior to the comparisons taking place.

### Request a comparison

The NMI contact the BIPM staff by mail [dosimetry@bipm.org](mailto:dosimetry@bipm.org), preferably one year before the wishing period, requesting the comparison(s) and informing the instruments that will be used.

The BIPM and the NMI agree on the date to carry out the comparison. The NMI must fill in the forms sent by the BIPM and returned them, following the corresponding instructions.

The NMI is expected to ensure the stability and good working conditions of their standard (primary and/or transfer) prior to the comparison and to make all the arrangements for its safe transport.

### Measurement procedure

The BIPM standards are used regularly to ensure the stability of the KCRV.

Direct comparison: the BIPM will determine the air kerma or absorbed dose to water using the NMI primary standard in the BIPM reference beams and compare the results with that determined using the BIPM standards. The NMI primary standard to be used in the comparison must be fully described and the measurement method equation should be fully detailed so as to ensure the traceability to the SI for the quantity being compared. A full uncertainty budget should be provided by the NMI in advance of the comparison.

Indirect comparison: the transfer standards must be calibrated at the NMI prior to the comparison at the BIPM and again after the measurements at the BIPM. The calibration coefficients of the transfer standards and the associated uncertainties should be given to the BIPM on arrival. The BIPM determines the NMI standard calibration coefficient, using the BIPM measurement system and compares with the results provided by the NMI.

### Comparison result

When a primary standard has been used, the comparison result is obtained as soon as the comparison measurements are completed and analysed.

When a transfer standard has been used, the NMI will normally need to check the calibration coefficients of the transfer standard on return to the NMI before the results are discussed. The post-calibration coefficients results should be sent to the BIPM within 4 weeks of the comparison measurements. This is important to identify any problems particularly with the use of a transfer standard during the comparison.

Uncertainties are evaluated at a level of one standard uncertainty

### Instrumentation transport

In general, each participating institute is responsible for its own costs regarding the measurements, transportation and any customs charges as well as any damage that may occur within its country.

If the NMI wishes to insure its standards, then it is the responsibility of the NMI to do so. The BIPM does not normally provide insurance but will be responsible in the event of damage while the instrumentation is in its care.

#### References

[1] Kessler C and Burns D T Measuring conditions and uncertainties for the comparison and calibration of national dosimetric standards at the BIPM *Rapport BIPM-2024/04*

[2] Allisy P J, Burns D and Andreo P International framework of traceability for radiation dosimetry quantities *Metrologia* 2009 **46(2)** S1-S8

[3] The CIPM MRA Key Comparison Database for dosimetry KCDB