

**Protocol for Key Comparison EURAMET.T-K1
(PTB, INRiM, INTiBS, NMi VSL, NPL)
Realisations of the ITS-90, 2.4 K to 24.5561 K,
using rhodium-iron resistance thermometers**

The measurement protocol for this regional Key Comparison is essentially the same as that used for CCT-K1, with the substitution of PTB as the pilot laboratory. In the temperature range from 2.4 K to 24.5561 K, the ITS-90 is defined by specifying vapour-pressure equations for ^3He (0,65 K to 3,2 K) and ^4He (1,25 K to 5,0 K) and interpolation equations for a constant-volume gas thermometer using ^3He or ^4He . The definitions are given in Sections 3.1 and 3.2 of the ITS-90 text, and practical methods for realising the scale in this range are outlined in Chapters 4 and 5 of the “Supplementary Information for the ITS-90”, BIPM 1990.

Realisations of the ITS-90 in this range are generally preserved and disseminated through calibrations of rhodium-iron resistance thermometers (RIRTs). The Key Comparison will be effected by comparing calibrations as have been established at PTB, INRiM, INTiBS, NMi VSL, NPL or in other national measurement institutes around the world. It is a pre-requisite of participation that the RIRTs have been calibrated in terms of an original local realisation of the ITS-90 over at least part of the range.

With the scope to get direct linking with the CCT-K1 comparison, the calibrations of two RIRTs of INRiM (serial numbers 232324 and B190) and INTiBS (serial numbers 93 and B178) will be compared in 2008 at PTB with the calibrations of the RIRTs of NMi VSL (serial number 226246), NPL (serial numbers 221481 and 221485), and PTB (serial numbers 229074 and 229075) that participated in CCT-K1. Measurements will be performed at a set of comparison temperatures similar in distribution to the original 31 CCT-K1 comparison temperatures in the range from about 2.4 K to 24.5561 K. The results will be recorded at the comparison temperatures as determined by the PTB reference RIRTs. These results will remain blind until after the measurements are completed.

Resistance values will be reported at zero current, with the self-heating correction determined from measurements made at two different excitation currents at each of the comparison temperatures. Measurements at PTB will be made via an ac resistance bridge operating at 25 Hz excitation frequency and calibrated traceably to the national standard. Resistance standards will be traceable to R_{K-90} via sets of standard resistors traceable to the Quantized Hall Resistance.

In addition to the CCT-K1 measurement protocol, optionally an initial series of measurements will be performed at both PTB and the other four institutes to establish stability of the RIRTs. The resistance values will be measured at the triple point of water (TPW) and/or at the triple point of equilibrium-hydrogen ($e\text{-H}_2$ TP) prior to their delivery to PTB. Upon delivery, the same initial measurements at the TPW and $e\text{-H}_2$ TP will then be performed at PTB prior to performing the full comparison. Upon the return of the RIRTs, the same initial measurements will be performed again at the other four institutes. The resistance values so obtained will be shared by the four institutes and PTB for comparison to establish stability of the RIRTs. All other resistance-temperature data will remain blind until their evaluation is completed.

Within 2007, the ITS-90 interpolation equations appropriate for the RIRTs of INRiM, INTiBS, NMi VSL, and NPL will be forwarded to the pilot together with information relating to the realisation (range, description, report or publication) and the RIRTs (source, construction).

These interpolation equations will be used together with preliminary comparison data to check the stability of the RIRTs prior to performing the full comparison. The full comparison data will then be used to generate $T_{\text{INRiM}} - T_{\text{PTB}}$, $T_{\text{INTiBS}} - T_{\text{PTB}}$, $T_{\text{NMiVSL}} - T_{\text{PTB}}$, and $T_{\text{NPL}} - T_{\text{PTB}}$ over the comparison range.

The zero-current resistance values, interpolated temperatures, temperature differences, and associated uncertainty budgets corresponding to the template used for CCT-K1 will be reported by INRiM, INTiBS, NMi VSL, NPL, and PTB. The Draft A report will be written by PTB, including preliminary analysis on the bilateral degrees of equivalence. Once approved by the participants, the Draft B report will be submitted to CCT-WG7 for inclusion in the BIPM Key Comparison Database, with the results cast in a form suitable for linking with CCT-K1.

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