

## Proposal for a Nomenclature for the MeP-K

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Based on an e-mail discussion within the task group for the *mise en pratique* for the definition of the kelvin (MeP-K) and on the document CCT/10-27, we propose the following nomenclature.

As the MeP-K has been under development, a variety of terms were used, e.g., primary, secondary, absolute, relative, direct, indirect etc. The purpose of this section is to clarify what is meant by the terms that will be used in the MeP-K document chapters on 1) primary thermometry, 2) defined temperature scales, and 3) approximations to thermodynamic temperature. Clear, well-defined nomenclature is needed to support an unambiguous taxonomy of methods in the MeP-K. Within the context of the MeP-K the terms below have following meanings:

1) *Primary thermometry* is performed using a thermometer based on a well-understood physical system, for which the equation of state describing the relation between thermodynamic temperature and other independent quantities, such as the ideal gas law or Planck's equation, can be written down explicitly without unknown or significantly temperature-dependent constants. Thermodynamic temperature can be obtained by measuring the independent quantities. Accurate temperature values require not only accurate measurements, but also a sufficient understanding of the system to enable quantitative assessment of departures from the ideal and applying appropriate corrections.

*Absolute primary thermometry* measures thermodynamic temperature directly in terms of the definition of the base unit, the kelvin, i.e., from the defined numerical value of the Boltzmann constant. No reference is made to any temperature fixed point ( $n = 0$ ,  $n$  number of points) and all other parameters specified in the equation of state are measured or otherwise determined.

*Relative primary thermometry* measures thermodynamic temperature indirectly using a specified equation of state, with one or more key parameter values determined from temperature fixed points ( $n > 0$ ), for which values for the thermodynamic temperature and their uncertainties are known from absolute or relative primary thermometry.

2) *Defined temperature scales* assign temperature values, which have been determined by primary thermometry, to a series of naturally occurring, highly reproducible states (e.g., freezing and triple points), specify the interpolating or extrapolating instruments for a particular subrange of temperature and define any necessary interpolating or extrapolating equations. The defined scales are highly prescriptive and define new temperature quantities  $T_{XX}$  that provide close approximations to the thermodynamic temperature  $T$  and have the same unit as  $T$ , i.e., the kelvin. Temperature values assigned to the fixed points of each scale are considered exact and do not change for the life of the scale, even if subsequent research reveals a bias of the values relative to true thermodynamic temperature. Currently, the only such defined temperature scales recommended by the CCT and approved by the CIPM are the International

Temperature Scale of 1990 (ITS-90) and the Provisional Low Temperature Scale from 0.9 mK to 1 K (PLTS-2000). The temperatures defined by ITS-90 and PLTS-2000 are  $T_{90}$  and  $T_{2000}$ . Non-prescriptive recommendations for the realisation of the ITS-90 and the PLTS-2000 are given in the “Supplementary Information for the International Temperature Scale of 1990” and the “Supplementary Information for the Realisation of the PLTS-2000”, respectively.

There exist also *approximations of defined scales* where fixed points, interpolating or extrapolating instruments, and interpolating or extrapolating equations are different from those specified in the defined scales, but any differences from a scale are sufficiently well understood. Such methods are described in the “Techniques for Approximating the International Temperature Scale of 1990” (new title “CCT Guidelines on Secondary Contact Thermometry”?).

3) *Approximations to thermodynamic temperature* do not explicitly use a specified equation of state but rather either some approximation to it, or an empirical relation (e.g., virial expansion for gases with experimentally determined virial coefficients, approximations to Planck’s law). Some or none of the parameters need to be explicitly determined but are arrived at through reference to temperature fixed points (e.g., fixed points of the defined scales together with data on the differences between thermodynamic temperature  $T$  and the assigned temperature values  $T_{XX}$ ) and some mathematical process (e.g., interpolation or least squares approach). These methods are used, in the place of a defined scale or primary thermometry, when some advantage such as lower uncertainty or increased reliability in realisation is achievable. For the MeP-K, only methods that can achieve uncertainties similar to the primary thermometry or defined scale approaches are included.