International Comparison CCQM-K150: Particle number concentration (100 to 20 000 cm^{-3}) and particle charge concentration (0.15 to 3 fC cm^{-3})

Guidance Note: Support for Calibration and Measurement Capabilities

1. Introduction

This guidance note is aimed at reviewers of calibration and measurement capabilities (CMCs), supported by the participation in a key comparison.

In principle, support to measurement capabilities is limited to those measurement results that are consistent with the key comparison reference value (KCRV). However, in this key comparison (CCQM-K150) [1], several measurement results were not consistent with the KCRV. For those results, based on the documented GAWG strategy for comparisons and CMC claims [2], this guidance note proposes that larger expanded uncertainties than the submitted uncertainties can be submitted as CMC claims. The idea behind allowing these these larger uncertainties is that:

1. National Metrology Institutes (NMIs) can still use their participation in a key comparison to support their measurement service
2. The stated uncertainty is large enough to ensure comparability with the KCRV and the results of other NMIs
3. There is a harmonised way of dealing with discrepant comparison results in relation to CMCs

Discrepant measurement results can occur for several reasons. For a discussion of the measurement results in CCQM-K150, see the final report [1]. In case of incidental discrepant results, the default response would be to investigate the cause of the discrepancy and to resolve it [3]. Hence, the expanded uncertainties set out in Tables 1 & 2 should not be viewed as any of the following:

1. A substitute for appropriate corrective measures from the side of the NMI to resolve the discrepancy
2. A consent from the GAWG that the submitted measurement result is acceptable
3. A guarantee that a CMC submitted in accordance with this guidance note will be accepted by reviewers in the review process by the Regional Metrology Organisations
4. Support for the metrological traceability of the measurement result submitted
5. A direction or recommendation to assessors in peer reviews or accreditation visits

2. 'How far the light shines' statement

For information, the 'how far the light shines' (HFTLS) statement for CCQM-K150 [1] is reproduced below:

The result of this key comparison can be used to support CMC claims for airborne particle number concentration, in the range 100 cm^{-3} to 20 000 cm^{-3} (using CPCs); and airborne particle charge concentration, in the range 0.15 fC cm^{-3} to 3 fC cm^{-3} (using AEs), equivalent to a concentration of elementary charges of approximately 1 000 cm^{-3} to 20 000 cm^{-3}. These claims apply to particles with electrical mobility diameters from 40 nm to 500 nm, made from all materials.

3. Support for CMCs

Tables 1 & 2 show the ranges of the CMC concentrations and the expanded uncertainties supported by participation in CCQM-K150 [1]. The comparisons using 40 nm and 50 nm aerosol particles are considered together.

The values in Tables 1 & 2 have been determined using the following criteria, applied to each of the five concentrations used in the comparison.

1. If the participant's result *'overlaps'* the KCRV within its agreed expanded uncertainty (including the component for the uncertainty of the KCRV) for *either* the 40 nm *or* 50 nm particles, the stated relative uncertainty of the overlapping result is deemed to be their CMC.
2. If the participant's result *'overlaps'* the KCRV within its agreed expanded uncertainty (including the component for the uncertainty of the KCRV) for *both* the 40 nm *and* 50 nm particles, the smaller of the two stated relative uncertainties is deemed to be their CMC.
3. If the participant's result *does not 'overlap'* the KRCV within its agreed expanded uncertainty (including the component for the uncertainty of the KCRV) for *neither* the 40 nm *nor* 50 nm particles, the KCRV, the CMC is calculated in accordance with GAWG strategy for comparisons and CMC claims [2]. The smaller of the two calculated values is deemed to be their CMC.
4. The concentration ranges over which the CMCs are applicable, and their relationship to the five concentrations at which the comparison was undertaken are also shown in Tables 1 & 2.

CMC charge concentration range / (fC cm^{-3})	**0.15 ≤ x < 0.24**	**0.24 ≤ x < 0.48**	**0.48 ≤ x < 1.12**	**1.12 ≤ x < 2.40**	**2.40 ≤ x < 3.00**
K150 charge concentration / (fC cm^{-3})	*0.16*	*0.32*	*0.64*	*1.6*	*3.2*
Laboratory	**Supported CMC uncertainty / %**				
NPL	1.19	1.01	0.99	1.00	0.98
KRISS	2.60	2.59	7.47 *	8.33 *	9.67 *
METAS	3.51	3.59	3.25	1.70	0.99
LNE	35.29	18.75	9.84	6.41	5.03
NMIJ	4.39	2.59	1.64	1.25	1.19
NIM	4.05	2.58	2.40	6.96	1.89
PTB	21.18	11.25	5.69	2.56	1.67

Table 1: Supported CMCs (in % relative) for particle charge concentration measured by AEs. Figures with an asterisk (*) indicate uncertainties that have been inflated because neither submitted measurement result was not consistent with the KCRV (see point 3 in Section 3). Note that this table does not include results from BAM, who are not eligible to claim CMCs from this comparison.

CMC number concentration range / (cm^{-3})	100 ≤ x < 550	550 ≤ x < 2 500	2 500 ≤ x < 7 000	7 000 ≤ x < 15 000	15 000 ≤ x < 20 000
K150 number concentration / (cm^{-3})	*100*	*1 000*	*4 000*	*10 000*	*20 000*
Laboratory	**Supported CMC uncertainty / %**				
NPL	3.46	3.50	3.50	3.50	3.50
KRISS	3.42	3.25	3.12	3.11	3.04
METAS	2.11	2.27	2.12	1.92	1.92
LNE	11.11	15.54 *	14.45 *	14.65 *	15.05 *
NMIJ	2.21	1.85	1.22	1.24	8.22 *
NIM	4.60	4.37	4.48	4.30	4.00
VNIIFTRI	32.91 *	15.31 *	23.52 *	17.43 *	17.24 *
PTB	11.69 *	11.53 *	11.61 *	12.97 *	14.07 *

Table 2: Supported CMCs (in % relative) for particle number concentration measured by CPCs. Figures with an asterisk (*) indicate uncertainties that have been inflated because neither submitted measurement result was not consistent with the KCRV (see point 3 in Section 3)

4. References

[1] A. S. Brown, P. Quincey, V. Ebert, A. Nowak, J. T. Tompkins, I. Hessey, K. Ciupek, C. Schaefer, O. Werhahn, K. Vasilatou, F. Lüönd, T. Macé, F. Gaie-Levrel, L. Bregonzio-Rozier, N. Oganyan, D. Belenkii, H. Sakurai, Y. Murashima, J. Liu, J. Jung and S. Seeger, *International comparison CCQM-K150: particle number concentration (100 to 20 000 cm^{-3}) and particle charge concentration (0.15 to 3 fC cm^{-3})*, Metrologia, 2023, 60, 08014.

[2] P. J. Brewer and A. M. H. van der Veen, *GAWG strategy for comparisons and CMC claims*. CCQM Gas Analysis Working Group document GAWG19-41-CCQM.

[3] International Standard ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratorie*s.