

Review Protocol for Humidity CMC's

1. **Scope:** To provide a method of reviewing thermometry CMC's in the sub-field humidity for acceptance in Appendix C of the KCDB.

The CMC review protocol described in this document is primarily designed for use during the inter-review of the CMC's by the RMOs and by the inter-RMO CMC review committee. These are the last phases in the review process of the CMC's. Earlier steps are the submission within the RMO and the review by the RMO. Then follows the inter-review process where the RMO review each others CMC's. Normally, most CMC's will receive an "acceptance" during the inter-review of the CMC's by the RMO's. The inter-RMO CMC review committee shall review only those CMC entries that are labelled "under review" from the RMO CMC review process. After the CMC review process is completed, the CMC's are submitted for general acceptance to the JCRB.

The inter-RMO CMC review committee shall consist of the RMO Thermometry Working Group Chairperson. Each chairperson may use "experts" from their respective RMO to assist in the inter-RMO CMC review committee review process.

The inter-RMO CMC review committee shall review only the "under review" CMC entries from the inter-review CMC process. For those CMC entries not receiving an "acceptance" from the inter-RMO CMC review committee, the NMI will be notified of which CMC entries require modifications to their uncertainty claims. The inter-RMO CMC review committee shall not decide what new value to give to the uncertainty entry to achieve an "acceptance" to the CMC entry, as that is the responsibility of the NMI.

The CMC review process is not to bluntly increase uncertainties. In such case the uncertainties become subject to political, rather than scientific arguments. The discussion must have a scientific basis: If during the CMC review any lab is asked to increase uncertainty claims it must be on the basis that a claim is clearly proven inconsistent.

At this point, the NMI has the option of either submitting a new CMC entry to the inter-RMO CMC review committee for another review or submitting the "under review" CMC entry to the JCRB through their RMO for resolution.

2. Acceptance Criteria and Scoring System

The CMC review protocol is primarily designed for use during the review of the CMC's by the RMOs and by the inter-RMO CMC review committee. Normally, most CMC's will receive an "acceptance" during the review of the CMC's by the RMOs. The scoring system simplifies the process of deciding which CMC receives "acceptance". Those CMC's not receiving "acceptance" will receive an "under review" status.

2.1 NMI claiming CMC's for Service 3.1

2.1.1 NMI participated in Key or Supplementary comparisons (RC)

2.1.1.1 If the difference between the NMI Comparison result and the RCRV (reference value) at each measurement point is within the $k=2$ uncertainty [which includes NMI CMC, RC (e.g. transfer standard), and RCRV uncertainties], the NMI CMC entry uncertainty is not smaller than the NMI RC uncertainty claim, and if the NMI CMC uncertainty claim is not less than one third of the combined RC and RCRV uncertainty, then the uncertainty is deemed acceptable in the measurement range of the NMI's results at the RC. ¹⁾ Refer to Table 4 for nomenclature.

$$\left| V_{NMI,RC} - V_{RCRV} \right| < \sqrt{U_{NMI\ CMC}^2(k=2) + U_{RC}^2(k=2) + U_{RCRV}^2(k=2)} \quad (1)$$

and

$$u_{NMI\ CMC} \geq u_{NMI,RC} \quad (2)$$

and

$$u_{NMI\ CMC} > \frac{u_{RC\&\ RCRV}}{3} \quad (3)$$

2.1.1.2 If the criteria of 2.1.1.1 are not met but:

$$\left| V_{NMI,RC} - V_{RCRV} \right| < \sqrt{U_{NMI\ CMC}^2(k=3) + U_{RC}^2(k=3) + U_{RCRV}^2(k=3)} \quad (4)$$

and

$$U_{NMI\ CMC}(k=2) \geq \text{Table 2 value} \quad (5)$$

and

¹⁾ It is assumed that the number of effective degrees of freedom is large enough to give a coverage probability of approximately 95 % with $k=2$.

$$U_{RC\&RCRV}(k=2) < \text{Table 3 value} \quad (6)$$

and

$$-60\text{ °C} \leq V_{RCRV} \leq +75\text{ °C} \quad (7)$$

the uncertainty is deemed acceptable.

2.1.1.3 If the criteria of 2.1.1.1 or 2.1.1.2 are met except in a single point that is not an extreme value of the range, the uncertainty is deemed acceptable.

2.1.1.4 If the criteria of 2.1.1.1 or 2.1.1.2 are met in the range of the NMI's results at the RC, the uncertainty is also deemed acceptable in an extended range from t_{dMin} to t_{dMax} if:

the claimed uncertainty in the extended range below t_{dL} or above t_{dH} is not smaller than at t_{dL} or t_{dH} , respectively.

The limits of the extended range are given in table 1.

Table 1 Acceptable extension to the range of the NMI's results at the Key or Supplementary comparison

| Dew/frost-point temperature range ¹⁾ | Acceptable extended range ²⁾ |
|--|---|
| $-35\text{ °C} \leq t_{dL}, t_{dH} \leq +45\text{ °C}$ | $t_{dMin} = t_{dL} - 10\text{ °C}$ or $t_{dMin} = -40\text{ °C}$ whichever is higher $t_{dMax} = t_{dH} + 10\text{ °C}$ or $t_{dMax} = +50\text{ °C}$ whichever is lower |
| $-75\text{ °C} \leq t_{dL}, t_{dH} < -35\text{ °C}$ and $+45\text{ °C} < t_{dL}, t_{dH} \leq +75\text{ °C}$ | $t_{dMin} = t_{dL} - 5\text{ °C}$ or $t_{dMin} = -75\text{ °C}$ whichever is higher $t_{dMax} = t_{dH} + 5\text{ °C}$ or $t_{dMax} = +75\text{ °C}$ whichever is lower |
| $t_{dL}, t_{dH} < -75\text{ °C}$ and $t_{dL}, t_{dH} > +75\text{ °C}$ | No extension |

¹⁾ t_{dL}, t_{dH} : Minimum and maximum of the range of the NMI's results at the RC, respectively

²⁾ t_{dMin}, t_{dMax} : Minimum and maximum of the acceptable extended range, respectively

For example, if an NMI has obtained results fulfilling the criteria of 2.1.1.1 in the range from -50 °C to $+20\text{ °C}$ the uncertainty claimed by the NMI is deemed acceptable in the range from -55 °C to $+30\text{ °C}$.

2.1.1.5 If the CMC is acceptable with respect to 2.1.1.4, but CMC is also claimed in a dew/frost-point temperature range outside the extended range (according to 2.1.1.4) of the NMI's results at the RC, then the uncertainty claim requires scrutiny by the NMI's RMO Thermometry Working Group.

- 2.1.1.6 In all other cases, the NMI CMC uncertainty claim requires scrutiny by the CCT WG8.

2.1.2 NMI not participated in Key or Supplementary Comparisons

- 2.1.2.1 If the NMI has not participated in a Key or Supplementary Comparison and the uncertainty claim is larger than the values given in Table 3, then the uncertainty is deemed acceptable.

$$U_{NMI\ CMC} > \text{Table 3 value} \quad (8)$$

- 2.1.2.2 If the NMI has not participated in a Key or Supplementary Comparison and the uncertainty claim is smaller than the values given in Table 3, then the uncertainty claim requires scrutiny by the NMI's RMO Thermometry Working Group.

- 2.1.2.3 If the NMI has not participated in Key or a Supplementary Comparison and the CMC is claimed in a dew/frost-point temperature range outside the range of tables 2 to 3, then the uncertainty claim requires scrutiny by the CCT WG8.

Table 2. Review criteria uncertainty values, low limit based on 25th percentiles calculated from uncertainties reported in comparisons EUROMET P511 and APMP K6

| $T_{dew}/^{\circ}\text{C}$ | -60 | -50 | -40 | -30 | -20 | -10 | 5 | 15 | 30 | 45 | 60 | 75 |
|--|------|------|------|------|------|------|------|------|------|------|------|------|
| 25 th percentile / $^{\circ}\text{C}$ | 0.07 | 0.06 | 0.05 | 0.05 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.05 |

Table 3. Review criteria uncertainty values, low limit based on twice the 75th percentiles calculated from uncertainties reported in comparisons EUROMET P511 and APMP K6

| $T_{dew}/^{\circ}\text{C}$ | -60 | -50 | -40 | -30 | -20 | -10 | 5 | 15 | 30 | 45 | 60 | 75 |
|----------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| $^{\circ}\text{C}$ | 0.32 | 0.26 | 0.22 | 0.18 | 0.16 | 0.16 | 0.16 | 0.18 | 0.20 | 0.20 | 0.20 | 0.20 |

Table 4: Nomenclature

| | |
|----------------|--|
| RC | Key or Supplementary comparisons |
| RCRV | Key or Supplementary reference value |
| $V_{NMI,RC}$ | NMI Comparison result |
| $u_{NMI,RC}$ | Standard uncertainty of $V_{NMI,RC}$ |
| V_{RCRV} | Reference value of the comparison |
| U_{RCRV} | expanded uncertainty $U_{RCRV} = k \cdot u_{RCRV}$ where u_{RCRV} is the standard uncertainty of V_{RCRV} (coverage factor given in the parentheses) |
| $U_{NMI\ CMC}$ | expanded uncertainty $U_{NMI\ CMC} = k \cdot u_{NMI\ CMC}$ where $u_{NMI\ CMC}$ is the NMI CMC standard uncertainty claim (coverage factor given in the parentheses) |
| U_{RC} | expanded uncertainty $U_{RC} = k \cdot u_{RC}$ where u_{RC} is the standard uncertainty related to the comparison transfer standard (coverage factor k given in the parentheses) |
| $u_{RC\&RCRV}$ | Combined standard uncertainty of u_{RC} and u_{RCRV} , ie. $u_{RC\&RCRV} = \sqrt{u_{RC}^2 + u_{RCRV}^2}$. |

3. Further scrutiny: Knowledge of NMI's calibration capabilities

- 3.1 Must be accepted by the NMI's RMO Humidity Metrology Working Group
- 3.2 Supporting documentation (supplementary comparisons, papers or unpublished results) as required by the NMI's RMO Humidity Metrology Working Group
- 3.3 Detailed uncertainty budget.
- 3.4 Acceptance by the WG8 review committee.