Report of WG8 to the 22nd session of the Comité Consultatif de Thermométrie

Membership:
Martin de Groot, Greg Strouse, Mark Ballico, Richard Rusby, Peter Steur, Anatoly Pokhudun (co-opted). During some meetings experts were called in to provide assistance.

Introduction
The working group has struggled with its terms of reference. The task related to service categories assigned at the 21st session of the CCT was clear. However, the implementation of the JCRB/CIPM recommendation on CC working groups on Calibration and Measurement Capabilities was not clear. CMC review activities reported here were organized under RMO-authority existing of the thermometry chairmen of the RMO's and at most two experts from each region, this was called the inter-RMO CMC review committee. This committee convened October 2002 in Chicago and March 2003 in Washington. CCT WG8 met twice: October 2002 in Chicago and on 13 May 2003 preceding the CCT meeting. The CCT working group reports the outcome of the inter-RMO CMC review committee on behalf of this committee.

Service Categories:
This was discussed by the WG8 at a meeting in Chicago. The meeting of was attended by Martin de Groot, Gregory Strouse, Richard Rusby, Peter Steur, Anatoly Pokhodun, Hans Liedberg, Mark Ballico, Also present: CCT president, Huseyin Ugur, CCT executive secretary Michael Stock, experts from Coomet Mikhail Matveyev, Alina Ivanova, NIST radiation dept, Gerald Frazer, Carol Johnson, Howard Yoon. Apart from the regular WG8 members regional experts had been called in to discuss the need for CMCs to be submitted on thermodynamic temperature scale realizations.

After an explanation of Gerald Frazer that NIST rather disseminates their primary radiation thermometer with effective traceability to irradiance/radiance facilities the traceability is through the Planck constant. More and more national laboratories are tending to follow similar techniques. The compatibility of the scales needs to be verified and this is subject of discussion in CCT WG5. Conclusion: amend title of entries 1 to read *Temperature, items used for realisation of ITS-90 and for thermodynamic temperature measurements*.

Other entries were changed and added to agree with this decision. Some other entries were renamed or added to allow the CMCs to cover current practice in all regions.

Entries on Thermophysical properties were not discussed, but left for CCT WG9 to define further. CCT WG9 and CCT WG5 shall need to consider possible overlap with service categories defined by other CC's. We are asking these working groups to examine the service categories and advise CCT WG8 where these categories would most appropriately be placed.

Other CMC related issues
There have been two meetings of the inter-RMO CMC review committee on CMCs. The first meeting was in Chicago with all RMO chairmen present or represented: Mark Ballico for APMP, Martin de Groot for Euromet, Anatoly Pokhudun for COOMET, Hans Liedberg for SADCMET and Greg Strouse (SIM and chairman of this meeting). The meeting was also attended by Hratch Semerjian of NIST, Michael Stock and Huseyin Ugur. The second meeting in Washington was attended by Mark Ballico (APMP), Anatoly Pokhodun (COOMET), Martin de Groot (EUROMET and chairman), Gregory Strouse (SIM). For EUROMET Richard Rusby and Erich Tegeler attended for expert assistance. For SIM Weston Tew was attending as expert. Dennis Minor of NIST was secretary.

Items of the discussion in Chicago were the CMC review status, the recommendation of CMC review working groups for the CC's and a plan to proceed from the apparent dead-lock between the regions. Large amounts of information had been exchanged between the regions to support CMCs but there were differences between approaches that could not be resolved by correspondence alone. First, these differences had to be identified.

Prior to the Washington meeting the RMO chairmen have drafted a protocol, which was very much amended and agreed during the meeting. Appendix 2 is a diagram showing the structure of the procedure used to identify the CMCs for scrutiny. These are the CMCs that

- should be looked at in detail by the inter-RMO CMC review committee,
- should be asked for further evaluation from the (local) RMO review groups and
- could be accepted without debate.

The system relies primarily on the key comparisons and its key comparison reference value. Two tables were produced to identify which CMCs need further scrutiny. These use respectively the 25th and 75th percentile of the CMCs of laboratories participating to the key comparison. In the future the method of generation of these tables will have to be looked at anew for application to other service categories.

The protocol is reproduced in appendix 3.

Using the protocol the inter-Review Committee looked at the CMCs under service category 1.3 SPRTs at fixed points that related to CCT-K2 (capsule SPRT hydrogen to watertp), CCT-K3 (long stem SPRT, argon to aluminium) and CCT-K4 (fixed points aluminium and silver). For Key comparison 3 NIST has produced an average reference value based on the average of the median, mean and weighted mean of the data measured by the participating laboratories. The uncertainty of the ARV was taken to be the standard deviation from these three KCRV estimates. Documents CCT/03-27 and CCT/03-28 have been submitted on the ARV to the CCT for discussion. The CCT WG8 wishes to emphasise that the ARV is a pragmatic solution to the specific problem arising from CCT K3 for which at present an unambiguous statistical solution is not available.

As to the quality system evaluation: the inter-RMO CMC review committee agreed that this should be looked at by the RMO review committee in its own right and that if the RMO thinks it is ok, the inter-RMO CMC review committee should not waste time on the subject.

There are points left to clear: we shall need to look at the water triple point entries on the basis of the results that are expected not too long from now from CCT-K7 on water triple points. There is a significant difference in approach of calibration/certification of fixed point cells (as shown in the table on the next page). The Euromet approach (that also seems to be followed by SADCMET and APMP) cannot simply be compared with the NIST/SIM and perhaps also COOMET approach. While we think we understand the real differences of these approaches, we want to clarify things further before accepting CMCs for entries 1.1 and 1.2.

The subrange SPRT CMCs under 1.3 need discussion of the inclusion of type 1 and type 3 non-uniqueness before we can accept those for all labs. In the absence of a short-term solution provided by CCT WG3 and CCT WG1 the inter-RMO review committee shall need to find a solution for this on the basis of available data. A table similar to tables 1 and 2 of the protocol has to be made for the evaluation of SPRTs over ranges, on the basis of the submitted CMCs from key comparison participants that are under review.

Entries for radiation thermometry and dew point hygrometer are scheduled for discussion during the next meeting.

It was agreed that the inter-RMO CMC review committee shall look at consistency between the regions of the approach for disseminating items (under section 2 of the service categories) so that these can be accepted immediately without further delay once they are accepted by the RMO review groups.

Harmonization of Thermometry CMC		
EUROMET Style		
Instrument or Artifact	**Calibration**	**Uncertainty**
Fixed-Point Cell	Certification	Single Number
SPRT at Fixed Point	Single-point calibration	Single Number
SPRT over ITS-90 Calibration Range	Multi-point calibration	Single Number
SIM Style		
Instrument or Artifact	**Calibration**	**Uncertainty**
Fixed-Point Cell	Certification	Single Number
SPRT at Fixed Point	currently not used	
SPRT over ITS-90 Calibration Range	Multi-point calibration	Range

Appendix 1 CMC entries

TEMPERATURE
1 Temperature - Items Used for Realising ITS-90 and thermodynamic temperature measurement
1.1 Primary Fixed-point Cells
1.1.1 contact thermometry
1.1.2 radiation thermometry
1.2 Complete Apparatus Realizing Fixed-points
1.2.1 Contact thermometry
1.2.2 Radiation thermometry
1.3 Standard Platinum Resistance Thermometers (SPRTs)
1.3.1 Capsule-type SPRTs
1.3.2 Long-stem SPRTs including HTSPRTs
1.4 Standard Radiation Thermometers
1.5 thermodynamic measurements
1.5.1 Absolute radiation thermometers
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2 Temperature - Items Used for Disseminating ITS-90 and thermodynamic temperatures
2.1 Secondary Fixed-point Cells and Apparatus, for Contact Thermometry
2.2 Resistance Thermometers (RTs)
2.2.1 Rhodium-iron resistance thermometers
2.2.2 Platinum resistance thermometers (PRTs)
2.2.3 Thermistors
2.2.4 Other resistive thermometers
2.3 Thermocouples
2.3.1 Noble-metal thermocouples
2.3.2 Base-metal thermocouples
2.3.3 Other type thermocouples
2.4 Liquid-in-glass Thermometers
2.5 Radiation Thermometry
2.5.1 Secondary fixed-point blackbody cells and complete instruments
2.5.2 Variable temperature blackbody radiation sources
2.5.3 Strip lamps
2.5.4 Radiation thermometers
2.5.5 Visual radiation thermometers
2.5.6 Detector-based radiation thermometers
2.6 Other Thermometers
2.7 Temperature Sensors with Display Unit (Digital System Thermometer)
2.8 Other Measurement Services
2.8.1 Bridge linearity
2.8.2 Compensation wires for reference junction
2.8.3 Fixed point materials for melting point measurements
2.8.4 Temperature indicators
2.8.5 Reference junction compensators
2.8.6 other
HUMIDITY
3 Hygrometers
3.1 Dew/frost-point Hygrometers
3.2 Psychrometers
3.3 Relative Humidity Sensors
3.4 Others
4 Dynamic Humidity Generators
4.1 Dew/frost-point generators
4.2 Relative humidity generators
4.3 Flow mixing
4.4 Permeation tube/diffusion tube
5 Static Humidity Generators
5.1 Salt solution (saturated/unsaturated)
5.2 Reference gases

THERMOPHYSICAL QUANTITIES

6 Thermal Conductivity

- 6.1 Absolute Measurements
  - 6.1.1 Longitudinal flow
  - 6.1.2 Radial flow
  - 6.1.3 Hot wire
  - 6.1.4 Transient hot strip
  - 6.1.5 Others
- 6.2 Relative Measurements
  - 6.2.1 Longitudinal flow
  - 6.2.2 Radial flow
  - 6.2.3 Others
- 6.3 Reference Materials

7 Thermal Diffusivity

- 7.1 Measurements
  - 7.1.1 Laser flash
  - 7.1.2 Transient hot strip
  - 7.1.3 Others
- 7.2 Reference Materials

8 Thermal Expansion Coefficient

- 8.1 Absolute Measurements
- 8.2 Relative Measurements
  - 8.2.1 Push rod
  - 8.2.2 Others
- 8.3 Reference Materials

9 Emissivity

- 9 Total Emissivity Measurements
  - 9.1.1 Directional
  - 9.1.2 Hemispherical
- 9 Spectral Emissivity Measurements
  - 9.2.1 Directional
  - 9.2.2 Hemispherical
- 9 Total Emissivity Reference Materials
  - 9.3.1 Directional
  - 9.3.2 Hemispherical
- 9 Spectral Emissivity Reference Materials
  - 9.4.1 Directional
  - 9.4.2 Hemispherical

10 Reflectance (Follow CCPR)

- 10 Total Reflectance Measurements
  - 10.1.1 Diffuse
  - 10.1.2 Regular
  - 10.1.3 Hemispherical
  - 10.1.4 BRDF
  - 10.1.5 Reflectance Factor
  - 10.1.6 Radiance Factor
- 10 Reference materials for Total
  - 10.2.1 Diffuse
  - 10.2.2 Regular
  - 10.2.3 Hemispherical
  - 10.2.4 BRDF
  - 10.2.5 Reflectance Factor
  - 10.2.6 Radiance Factor
- 10.3 Spectral Reflectance Measurements
  - 10.3.1 Diffuse
  - 10.3.2 Regular
  - 10.3.3 Hemispherical
  - 10.3.4 BRDF
  - 10.3.5 Reflectance Factor
  - 10.3.6 Radiance Factor
- 10.4 Reference materials for Spectral Reflectance
  - 10.4.1 Diffuse
  - 10.4.2 Regular
  - 10.4.3 Hemispherical
  - 10.4.4 BRDF
  - 10.4.5 Reflectance Factor
  - 10.4.6 Radiance Factor

11 Specific Heat Capacity

- 11.1 Measurements
  - 11.1.1 Adiabatic calorimetry
  - 11.1.2 Drop calorimetry
  - 11.1.3 Differential scanning calorimetry
  - 11.1.4 Relaxation method
  - 11.1.5 Laser flash
  - 11.1.6 Electrical pulse heating
  - 11.1.7 Optical modulation heating
  - 11.1.8 Others
- 11.2 Reference Materials

12 Heat of Transition
(fusion, vaporization.sublimation, phase transition)

- 12.1 Measurements
  - 12.1.1 Adiabatic calorimetry
  - 12.1.2 Drop calorimetry
  - 12.1.3 Differential scanning calorimetry
  - 2.1.4 Others
- 12.2 Reference Materials
  - 12.2.1 Fusion
  - 12.2.2 Vaporization
  - 12.2.3 Sublimation
  - 12.2.4 Phase/glass transition

13 Heat of Combustion

- 13.1 Measurements
  - 13.1.1 Combustion in oxygen
  - 13.1.2 Others
- 13.2 Reference Materials
  - 13.2.1 Combustion in oxygen
  - 13.2.2 Others

14 Heat of Reaction and Solution

- 14.1 Measurements
  - 14.1.1 Flow calorimeter
  - 14.1.2 Heat conduction calorimetry
  - 14.1.3 Isoperibolic calorimetry
  - 14.1.4 Titration
  - 14.1.5 Differential scanning calorimetry
- 14.2 Reference Materials

15 Heat Flux

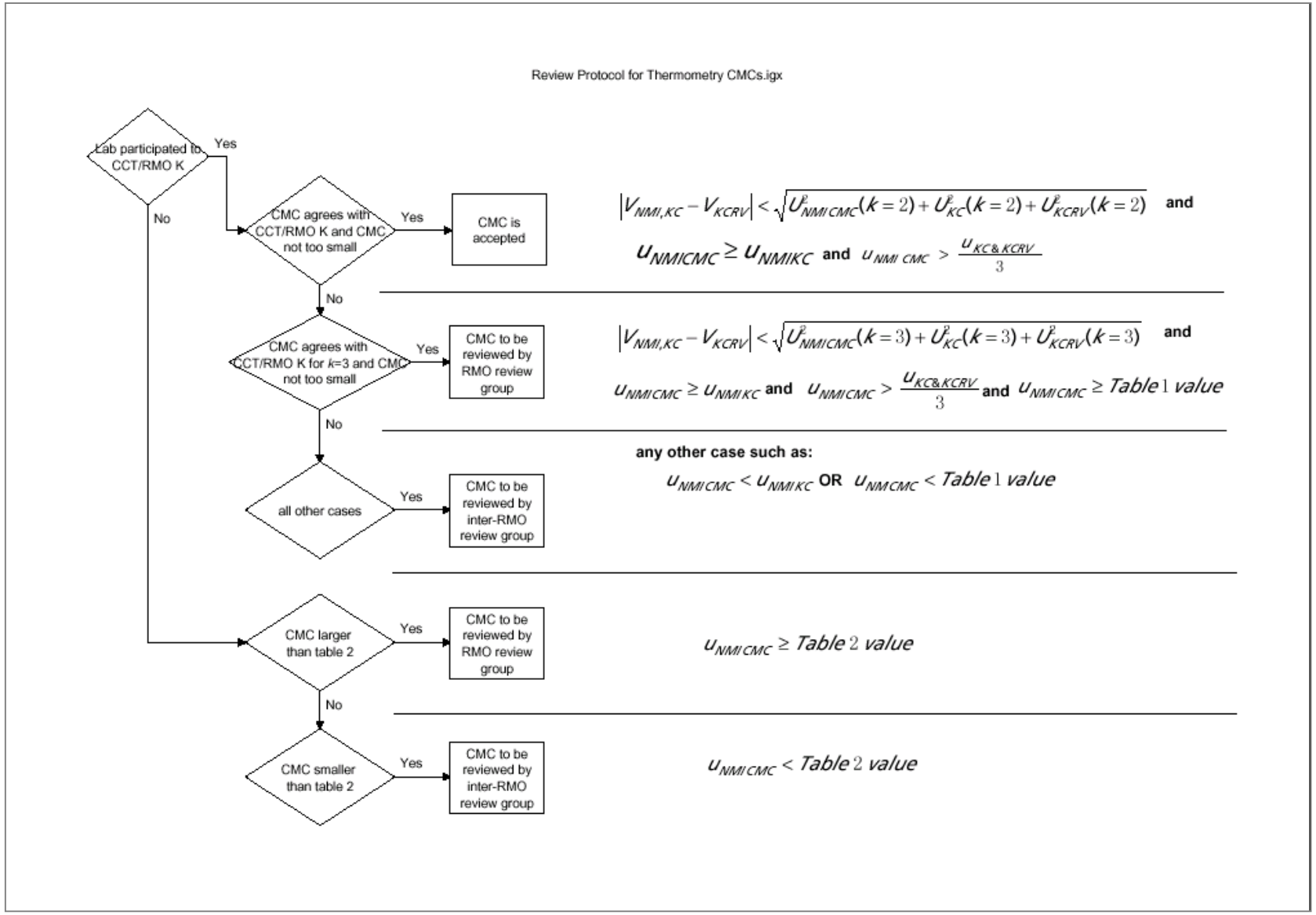
15.1 Radiative

- 15.1.1 Sensor Responsivity Measurements

15.2 Non radiative

- 15.2.1 Sensor Responsivity Measurements

Appendix 2 Protocol, Criteria selection table (tables referenced are in appendix 3)



Appendix 3: RMO CMC Review Protocol Document

Review Protocol for Thermometry CMCs

1. **Scope:** To provide a method of reviewing thermometry CMCs for acceptance in Appendix C of the KCDB.

The Acceptance Criteria and Scoring System given in this document incorporates the CMC review protocol from the MRA, JCRB guidelines (10/01), EUROMET Guides 8 and 9, APMP CMC review protocol (11/01), and SIM review protocol (11/01). Currently each RMO Thermometry Working Group is using their own RMO CMC review protocol to review the CMCs within their RMO prior to sending the CMCs to the JCRB for inter-review of the CMCs.

The CMC review protocol described in this document is primarily designed for use during the inter-review of the CMCs by the RMOs and by the inter-RMO CMC review committee. These are the last phases in the review process of the CMCs. 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 CMCs. Normally, most CMCs will receive an "acceptance" during the inter-review of the CMCs by the RMOs. The inter-RMO CMC review committee shall review only those CMC entries that are labeled "under review" from the RMO CMC review process. After the CMC review process is completed, the CMCs 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. We all want the discussion to 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. Pre-Screening of CMC entries

It is intended that this review protocol be used to statistically sample the CMC entries of an NMI by the reviewing RMO during the inter-review process. Pre-screening of the CMC entries can be used to judge which uncertainty claims receive an "under review" status and require further scrutiny by the inter-RMO CMC review committee. The following rules may be applied to pre-screen the CMC entries:

Note: Currently, Tables 1 and 2 are for ITS-90 fixed-point cells. Further expansion to accommodate other types of thermometers is forthcoming on acceptance of this document by the RMO Thermometry Working Group Chairpersons.

2.1 Accredited NMI

2.1.1 If an ILAC signatory accreditation body accredits the NMI and the accreditation is current, then the NMI receives "acceptance" for the Section 1 (Quality System) and Section 2 (Knowledge of NMI's calibration capabilities) of the Acceptance Criteria for those CMC entries covered by that accreditation. However, as mandated by the MRA, an NMI must undertake a comparison (Key or Supplemental) to receive "acceptance" for Section 3 (Uncertainties) of the Acceptance Criteria by December 2003 (date of the end of provisional status). At the deadline, if a laboratory does not meet this deadline, the RMO chairperson has to notify the JCRB which CMCs this relates to. The lab is allowed an extension of the provisional status until a date to be specified in this notification to the JCRB.

2.2 NMI with Key Comparison Results

2.2.1 If the difference between the NMI Key Comparison (KC) result and the KCRV is within the k=2 uncertainty [which includes NMI CMC, KC (e.g. transfer standard), and KCRV uncertainties], the NMI CMC entry uncertainty is not smaller than the NMI KC uncertainty claim, and the NMI CMC uncertainty claim is not less than one third of the combined Key Comparison and KCRV uncertainty, then the Uncertainty Section of the Acceptance Criteria is deemed acceptable. If the KC is published without a KCRV, then the Pilot Laboratory may be asked to provide a linkage mechanism to aid in the evaluation of the CMC entries with respect to the KC.

$$\left|V_{NMI,KC} - V_{KCRV}\right| < \sqrt{U^2_{NMI\,CMC}(k=2) + U^2_{KC}(k=2) + U^2_{KCRV}(k=2)}$$

and

$$u_{NMI\,CMC} \geq u_{NMI\,KC}$$

and

$$u_{NMI\,CMC} > \frac{u_{KC\&KCRV}}{3}$$

2.2.2 If the difference between the NMI Key Comparison (KC) result and the KCRV is within the (k=3) uncertainty [which includes NMI CMC, KC, and KCRV uncertainties], the NMI CMC entry uncertainty is not smaller than the NMI KC uncertainty claim, the NMI CMC entry uncertainty is larger or equal to the values given Table 1, and the NMI uncertainty claim is not less than one third of the combined Key Comparison and KCRV uncertainty, then the uncertainty claim requires scrutiny by the RMO Thermometry Working Group for that NMI. If the KC is published without a KCRV, then the Pilot Laboratory may be asked to provide a linkage mechanism to aid in the evaluation of the CMC entries with respect to the KC.

$$\left|V_{NMI,KC} - V_{KCRV}\right| < \sqrt{U^2_{NMI\,CMC}(k=3) + U^2_{KC}(k=3) + U^2_{KCRV}(k=3)}$$

and

$$u_{NMI\,CMC} \geq u_{NMI\,KC}$$

and

$$u_{NMI\,CMC} > \frac{u_{KC\,\&\,KCRV}}{3}$$

and

$$u_{NMI\,CMC} \geq Table\,1\,value$$

2.2.3 In all other cases, the NMI CMC uncertainty claim requires scrutiny by the inter-RMO CMC review committee.

For example:

$$u_{NMI\,CMC} < u_{NMI\,KC}$$

or

$$u_{NM\,CMC} < Table\,1\,value$$

2.3 NMI with no Key Comparison Results

2.3.1 If the NMI has not participated in a Key Comparison and the uncertainty claim is larger than the values given in Table 2, then the uncertainty claim requires scrutiny by the NMI's RMO Thermometry Working Group.

Note: This is Provisional and will be deleted when the RMO KCs are complete. An NMI must have a planned participation in a KC, and their CMC entries will be re-evaluated upon completion of a KC.

2.3.2 If the NMI has not participated in a Key Comparison and the uncertainty claim is smaller than the values given in Table 2, then the uncertainty claim requires scrutiny by the NMI's RMO Thermometry Working Group and the inter-RMO CMC review committee.

Note: This is Provisional and will be deleted when the RMO KCs are complete. An NMI must have a planned participation in a KC, and their CMC entries will be re-evaluated upon completion of a KC.

Table 1. Review criteria uncertainty values for those NMI's that have completed participation in a Key Comparison. Values are the 25th percentile of the CCT NMI CMC entry uncertainty (k=2) values.

Fixed Point Cells for Capsule SPRT Calibrations					
Fixed Point Cell	25th percentile U (k=2), mK	Fixed Point Cell	25th percentile U (k=2), mK	Fixed Point Cell	25th percentile U (k=2), mK
e-H_2	0.33	Ne	0.32	Hg	0.16
17 K	0.26	O_2	0.20	H_2O	0.10
20.3 K	0.24	Ar	0.18	Ga	0.20
Fixed Point Cells for Long-Stem SPRT Calibrations					
Fixed Point Cell	25th percentile U (k=2), mK	Fixed Point Cell	25th percentile U (k=2), mK	Fixed Point Cell	25th percentile U (k=2), mK
Ar	0.38	Ga	0.20	Zn	0.90
Hg	0.23	In	0.70	Al	1.90
H_2O	0.10	Sn	0.60	Ag	3.00

Table 2. Review criteria uncertainty values for those NMI's that have **not** completed participation in a Key Comparison. Values are the 75th percentile (median) of the CCT NMI CMC entry uncertainty (k=2) values.

Fixed Point Cells for Capsule SPRT Calibrations					
Fixed Point Cell	75th percentile U (k=2), mK	Fixed Point Cell	75th percentile U (k=2), mK	Fixed Point Cell	75th percentile U (k=2), mK
e-H_2	0.40	Ne	0.40	Hg	0.32
17 K	0.35	O_2	0.39	H_2O	0.27
20.3 K	0.35	Ar	0.33	Ga	0.40
Fixed Point Cells for Long-Stem SPRT Calibrations					
Fixed Point Cell	75th percentile U (k=2), mK	Fixed Point Cell	75th percentile U (k=2), mK	Fixed Point Cell	75th percentile U (k=2), mK
Ar	0.85	Ga	0.40	Zn	1.50
Hg	0.40	In	0.85	Al	2.75
H_2O	0.16	Sn	0.85	Ag	4.75

The Acceptance Criteria and Scoring System is designed to be used after the Pre-Screening process has been used to decide which CMC entries requires review. The CMC review protocol is primarily designed for use during the review of the CMCs by the RMOs and by the inter-RMO CMC review committee. Normally, most CMCs will receive an "acceptance" during the review of the CMCs by the RMOs. The scoring system simplifies the process of deciding which CMC receives "acceptance". Those CMCs not receiving "acceptance" will receive an "under review" status. Sections 1 and 2 will be reviewed by only the RMO Thermometry Working Groups.

Acceptance Criteria and Scoring System

1. Quality System

1.1 Accredited Laboratory

1.1.1 What is the name of accreditation body?
1.1.2 Does accreditation cover the CMC?
1.1.3 Is the accreditation body part of the ILAC?
1.1.4 Is the expiration date of the accreditation valid?
1.1.5 What is the accreditation number?
1.1.6 Fulfill or participate in an appropriate comparison by December 2003 (date of the end of provisional status). At the deadline, if a laboratory does not meet this deadline, the RMO chairperson has to notify the JCRB which CMCs this relates to. The lab is allowed an extension of the provisional status until a date to be specified in this notification to the JCRB.

Scoring:
If all of the answers are acceptable, then the applicable CMC entries receive an "acceptable" rating for Sections 1 and 2.

1.2 Non-Accredited Laboratory

1.2.1 Does the NMI have a Quality System?
1.2.2 What standard does the Quality System follow?
1.2.3 Does the Quality System cover the CMC?
1.2.4 Self-declared?
1.2.5 Peer review by the appropriate committee?
1.2.6 Fulfill or participate in an appropriate comparison by December 2003 (date of the end of provisional status). At the deadline, if a laboratory does not meet this deadline, the RMO chairperson has to notify the JCRB which CMCs this relates to. The lab is allowed an extension of the provisional status until a date to be specified in this notification to the JCRB

Scoring:
1.2.1 Must give an acceptable answer.
1.2.2 Must give an acceptable answer.
1.2.3 Must give an acceptable answer.
1.2.4: If yes, then the NMI must provide a copy of the Quality System review for CMCs that undergo inter-RMO CMC committee scrutiny from Section 3.

1.2.5: If yes, then the NMI must provide a copy of the peer review for CMCs that undergo inter-RMO CMC committee scrutiny from Section 3.

Scoring:
If all of the answers are acceptable, then the applicable CMC entries receive an "acceptable" rating for this Section.

2. Knowledge of NMI's calibration capabilities

2.1 Technically competent (e.g. papers and talks by staff, staff training records)?
2.2 Participation in RMO projects (e.g. supplemental comparisons)?
2.3 Appropriate equipment and measurement procedures?

Scoring:
At least two acceptable answers are required for this section. If the NMI is unknown to the reviewing RMO, then the reviewing RMO may ask for appropriate documentation (e.g. papers and talks by staff, staff training records).

3. Uncertainties

3.1 If the difference between the NMI Key Comparison (KC) result and the KCRV is within the k=2 uncertainty [which includes NMI CMC, KC (e.g. transfer standard), and KCRV uncertainties], the NMI CMC entry uncertainty is not smaller than the NMI KC uncertainty claim, and the NMI CMC uncertainty claim is not less than one third of the combined Key Comparison and KCRV uncertainty, then the Uncertainty Section of the Acceptance Criteria is deemed acceptable. If the KC is published without a KCRV, then the Pilot Laboratory may be asked to provide a linkage mechanism to aid in the evaluation of the CMC entries with respect to the KC. See Section 2.2.1

$$\left|V_{NMI,KC} - V_{KCRV}\right| < \sqrt{U^2_{NMI\,CMC}(k=2) + U^2_{KC}(k=2) + U^2_{KCRV}(k=2)}$$

and

$$u_{NMI\,CMC} \geq u_{NMI\,KC}$$

and

$$u_{NMI\,CMC} > \frac{u_{KC\&KCRV}}{3}$$

Scoring:
If true, then the Uncertainty Section of the Acceptance Criteria is deemed acceptable.

3.2 If the difference between the NMI Key Comparison (KC) result and the KCRV is within the (k=3) uncertainty [which includes NMI CMC, KC, and KCRV

uncertainties], the NMI CMC entry uncertainty is not smaller than the NMI KC uncertainty claim, the NMI CMC entry uncertainty is larger or equal to the values given Table 1, and the NMI uncertainty claim is not less than one third of the combined Key Comparison and KCRV uncertainty, then the uncertainty claim requires scrutiny by the RMO Thermometry Working Group for that NMI. If the KC is published without a KCRV, then the Pilot Laboratory may be asked to provide a linkage mechanism to aid in the evaluation of the CMC entries with respect to the KC. See section 2.2.2.

$$\left|V_{NMI,KC} - V_{KCRV}\right| < \sqrt{U^2_{NMI\,CMC}(k=3) + U^2_{KC}(k=3) + U^2_{KCRV}(k=3)}$$

and

$$u_{NMI\,CMC} \geq u_{NMI\,KC}$$

and

$$u_{NMI\,CMC} > \frac{u_{KC\&KCRV}}{3}$$

and

$$u_{NMI\,CMC} \geq Table\,1\,value$$

3.2.1 Acceptance by the NMI's RMO Thermometry Metrology Working Group

Scoring:
If true, then the Uncertainty Section of the Acceptance Criteria is deemed acceptable.

3.3 In all other cases, the NMI CMC uncertainty claim requires scrutiny by the inter-RMO CMC review committee. See Section 2.2.3

For example:

$$u_{NMI\,CMC} < u_{NMI\,KC}$$

or

$$u_{NM\,CMC} < Table\,1\,value$$

3.4.1 Acceptance by the NMI's RMO Thermometry Metrology Working Group

3.4.2 Supporting documentation (e.g. papers, supplemental comparisons, unpublished results) as required by the NMI's RMO Thermometry Metrology Working Group
3.4.3 Detailed uncertainty budget
3.4.4 Acceptance by the inter-RMO CMC review committee

Scoring:
If all items are true, then the Uncertainty Section of the Acceptance Criteria is deemed acceptable.

3.5 If the NMI has not participated in a Key Comparison and the uncertainty claim is larger than the values given in Table 2.

Note: This is Provisional and will be deleted when the RKCs are complete. An NMI must have a planned participation in a KC, and their CMC entries will be re-evaluated upon completion of a KC.

3.5.1 Acceptance by the NMI's RMO Thermometry Metrology Working Group
3.5.2 Supporting documentation (e.g. papers, supplemental comparisons, unpublished results) as required by the NMI's RMO Thermometry Metrology Working Group
3.5.3 NMI must have planned participation in an appropriate comparison by December 2003.

Scoring:
If all items true, then the Uncertainty Section of the Acceptance Criteria is deemed acceptable.

3.6 If the NMI has not participated in a Key Comparison and the uncertainty claim is smaller than the values given in Table 2.

Note: This is Provisional and will be deleted when the RKCs are complete. An NMI must have a planned participation in a KC, and their CMC entries will be re-evaluated upon completion of a KC.

3.6.1 Acceptance by the NMI's RMO Thermometry Metrology Working Group
3.6.2 Supporting documentation (e.g. papers, supplemental comparisons, unpublished results) as required by the NMI's RMO Thermometry Metrology Working Group
3.6.3 Detailed uncertainty budget
3.6.4 Acceptance by the inter-RMO CMC review committee
3.6.5 NMI must have planned participation in an appropriate comparison by December 2003.

Scoring:
If all items are true, then the Uncertainty Section of the Acceptance Criteria is deemed acceptable.

Note: An acceptable rating is required for all three sections of the Acceptance Criteria for those CMC entries that are sampled from an NMI's CMC submission. Those CMC entries that are not sampled and subjected to the Acceptance Criteria of this document will be labeled with an "acceptance".