23rd Meeting of CCPR, Sep. 22-23, 2016, BIPM, Sevres, France

Report of
Working Group on Key-Comparisons

Chair Y. Ohno
WG-KC had its 2016 meeting at BIPM
9:00-18:00 Sep. 21, 2016

Agenda

1. Opening and introductions, appointment of recording secretary
2. Additions to the agenda
3. Documents presented to the meeting
4. Approval of the minutes of 2015 meeting (Beijing), Review of action items
5. Review of Membership of WG-KC and Task Groups
6. Review of Terms of Reference
7. Reports by pilots of on-going CCPR Key Comparisons
8. Reports on progress of CCPR supplementary comparisons
9. Reports from the RMOs on comparison activities
10. Proposals for new comparisons
11. 2nd-round CCPR KCs
12. Reports from Task Groups
13. General issues on RMO and CCPR Comparisons
14. Guidelines
15. Other business
16. Next meeting
<table>
<thead>
<tr>
<th>File</th>
<th>Title</th>
<th>Author</th>
<th>Latest update</th>
<th>File type/size</th>
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<tr>
<td>CCPR-WG-KC/16-01</td>
<td>WG-KC 2016 meeting agenda</td>
<td>Y. Ohno</td>
<td>2016/09/09</td>
<td>PDF 20 kbytes</td>
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<td>CCPR-WG-KC/16-02</td>
<td>CCPR-WG-KC 2015 minutes draft 2</td>
<td>M. Stock</td>
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<td>CCPR-WG-KC/16-03</td>
<td>WG-KC Taks Group list</td>
<td>Y. Ohno</td>
<td>2016/09/09</td>
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<td>CCPR-WG-KC/16-04</td>
<td>Final reports published since last meeting</td>
<td>Y. Ohno</td>
<td>2016/09/19</td>
<td>PDF 177 kbytes</td>
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<td>CCPR-WG-KC/16-05</td>
<td>WG-KC Terms of Reference Sep 2016</td>
<td>Y. Ohno</td>
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<td>PDF 98 kbytes</td>
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<td>CCPR-WG-KC/16-06</td>
<td>comparison between CCPR and Euramet guidelines fro RMO comparisons</td>
<td>E. Ikkonen</td>
<td>2016/09/09</td>
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<td>CCPR-WG-KC/16-07</td>
<td>Guidelines for RMO PR Sup. Comp.</td>
<td>Y. Ohno</td>
<td>2016/09/09</td>
<td>PDF 46 kbytes</td>
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<td>CCPR-WG-KC/16-09</td>
<td>NRC (pilot) report #3 of the CCPR-K3.2014 Luminous Intensity Comparison</td>
<td>A. A. Gaertner</td>
<td>2016/09/19</td>
<td>PDF 25 kbytes</td>
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<td>CCPR-WG-KC/16-10</td>
<td>List of planned RMO Comparisons</td>
<td>Y. Ohno</td>
<td>2016/09/20</td>
<td>EXCEL 13 kbytes</td>
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<td>CCPR-WG-KC/16-11</td>
<td>CCPR Pilot Comparison for Spectral Regular Transmittance in UV (280-400 nm)</td>
<td>N. Nel-Gold</td>
<td>2016/09/20</td>
<td>PDF 124 kbytes</td>
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WG-KC Membership

A new member, NIM (China), was approved in 2015.

Current members of WG-KC:
KRISS (Korea), LNE (France), MIKES (Finland), NIM (China), NIST (USA), NMIA (Australia), NMIJ (Japan), NPL (UK), NRC (Canada), PTB (Germany), VNIIOFI (Russia)
Pilot laboratories of on-going key comparisons – MSL (New Zealand) pilot of CCPR K6.

- We have WG-KC membership criteria, in WG-KC Terms of Reference document (CCPR-WG-KC/16-05)
Task Groups

TG-1 Pilot comparison for spectral regular transmittance in the UV
Chair: Natasha Nel-Sakharova (NMISA)    Members: NMISA, MSL, NPL, NRC, PTB

TG-2 RMO Linkage
Chair: Emma Woolliams (NPL)    Members: NPL, MIKES, NMIJ, KRISS

TG-3 Comparison analysis
Chair: Emma Woolliams (NPL)    Members: NPL, NIST, MSL, PTB, MIKES, NMIA, KRISS, VNIIOFI, NIM, CSIC

Subtask Group: A new appendix for CCPR-G2 providing guidance on the fixed-effects model
Members: MIKES (E. Ikonen), PTB (L. Werner), NPL (E. Woolliams), MSL (A. Koo), NIST (Y. Ohno) and NIM (Y. Lin).

TG-4 Pilot study for the use of alternative standards for photometric comparisons
Chair: MIKES (E. Ikonen)
Members: MIKES, KRISS, LNE, MIKES, MSL, NIST, NMIJ, NRC, PTB
CCPR comparisons completed since 2014

CCPR S3 Bilateral comparison on cryogenic radiometers between NPL and UME
Pilot: NPL
Final report published, August 2016

Pilot comparison on THz spectral responsivity
Pilot PTB
Participants: NIM, NIST, PTB
Report published.
On-going CCPR Key Comparisons

K6-2010 Regular Spectral Transmittance (MSL)  Draft B approved
K3 (2nd) Luminous intensity (NRC)  Draft A in preparation
K2.b (2nd) Spectral Responsivity 300 – 1000 nm (KRISS)  measurement in progress
K2.a (2nd) Spectral Responsivity 900 – 1600 nm (NPL)  Protocol has just been approved.
K4 (2nd) Luminous flux (NMIJ)  Protocol being finalized
• NPL withdrew from participation. EURAMET PR TC is to decide whether they select an NMI to fill this open position and which NMI. NPL offers GEC 200 W flux lamps available for purchase.
• LNE keeps 31 GEC 200 W flux lamps from BIPM, available for loan.
K1.a (2nd) Spectral Irradiance 250 – 2500 nm (VNIIOFI)  Protocol being developed.
Reports from the RMOs on comparison activities

We shared status of on-going Key and Supplementary Comparisons in APMP, AFRIMETS, COOMET, EURAMET, SIM

<Discussions>

• WG agreed that “RMOs are encouraged to report the status of consistency check after a comparison is completed, at annual WG-KC meeting.

• We developed List of Planned RMO PR comparisons, which is to be posted on public-access area of BIPM website. The list is updated annually.
### Planned RMO Key Comparisons

<table>
<thead>
<tr>
<th>RMO</th>
<th>KC No</th>
<th>quantity</th>
<th>year of measurement start</th>
<th>pilot</th>
<th>link labs</th>
<th>interested participants</th>
<th>remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>APMP</td>
<td>K1.a</td>
<td>spectral irradiance 250 nm ~ 2500 nm</td>
<td>2016</td>
<td>KRISS (Korea)</td>
<td>KRISS</td>
<td>NMIT, NPLI, NMISA, NIS (Egypt)</td>
<td>to be decided in 2015 whether linked to first or second round</td>
</tr>
<tr>
<td>AFRIMETS</td>
<td></td>
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</tr>
<tr>
<td>COOMET</td>
<td>K1.a</td>
<td>spectral irradiance 250 nm to 2500 nm</td>
<td>2017 or 02/2018</td>
<td>VNIIOFI</td>
<td>VNIIOFI, PTB (?)</td>
<td>NSC &quot;IM&quot; (Ukraine), BelGIM (Belarus), UME</td>
<td>Will be started just after CCPR-K1a measurements</td>
</tr>
<tr>
<td>EURAMET</td>
<td>K6.2015</td>
<td>Regular spectral transmittance (380 to 1000 nm)</td>
<td>2016</td>
<td>LNE</td>
<td>LNE, PTB</td>
<td>BelGIM, BIM (BG), CMI (CZ), INM-MD (MD), DMDM (RS), GUM (PL), INM (RO), INRIM (IT), IO-CSIC (ES), METAS (CH), NSC &quot;IM&quot; (UA), SP (SE), UME (TR), VSL (NL), VTT (FI)</td>
<td></td>
</tr>
<tr>
<td>EURAMET</td>
<td>K3</td>
<td>Luminous intensity or luminous responsivity</td>
<td>TBD</td>
<td>TBD</td>
<td>VSL</td>
<td>UME (TR), SMU (SK), VTT (FI), IPQ (PT), IO-CSIC (ES), GUM (PL), (VSL) [1], SP (SE), PTB (DE), INM (RO), BIM-NCM (BG), BEV (AT), DMDM (RS), INRIM (IT), CMI (CZ)</td>
<td></td>
</tr>
<tr>
<td>EURAMET</td>
<td>K4</td>
<td>Luminous flux</td>
<td>TBD</td>
<td>TBD</td>
<td></td>
<td>UME (TR), SMU (SK), VTT (FI), IPQ (PT), IO-CSIC (ES), GUM (PL), MKHE (HU), SP (SE), INM (RO), METAS (CH), BIM-NCM (BG), BEV (AT), DMDM (RS), NPL (UK), INRIM (IT), CMI (CZ)</td>
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<tr>
<td>EURAMET</td>
<td>K2.b</td>
<td>Spectral responsivity (300 nm to 1000 nm)</td>
<td>TBD</td>
<td>TBD</td>
<td></td>
<td>SMU (SK), VTT (FI), IPQ (PT), IO-CSIC (ES), GUM (PT), MKHE (HU), VSL (NL), METAS (CH), EIM (GR), SP (SE), INM (RO), BIM-NCM (BG), DMDM (RS), NPL (UK), INRIM (IT), CMI (CZ), JV (NO), UME (TR)</td>
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</table>
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### Continued

| EURAMET | K2.a | Spectral responsivity (900 nm to 1600 nm) | TBD | UME(TR), SMU(SK), VTT(FI), IOC-SIC(ES), GUM(PL), MKEH(HU), METAS(CH), EIM(GR), SP(SE), NPL(UK), INRIM(IT), CMI(CZ), JV(NO) |
| EURAMET | K1.a | Spectral irradiance (250 nm to 2500 nm) | TBD | UME(TR), SMU(SK), VTT(FI), IOC-SIC(ES), MKEH(HU), METAS(CH), EIM(GR), SP(SE), INM(RO), BIM-NCM(BG), DMDM(RS), NPL(UK), CMI(CZ) |
| EURAMET | K5   | Spectral diffuse reflectance (360 nm to 820 nm) | TBD | UME(TR), VTT(FI), IPQ(PT), GUM(PL), PTB(DE), METAS(CH), EIM(GR), SP(SE), INM(RO), BIM-NCM(BG), INRIM(IT), CMI(CZ) |
| EURAMET | K1.b | Spectral irradiance UV | TBD | UME(TR), MKEH(HU), EIM(GR), DMDM(RS), CMI(CZ) |
| EURAMET | K2.c | Spectral responsivity UV (200 nm to 400 nm) | TBD | UME(TR), SMU(SK), VTT(FI), IOC-SIC(ES), GUM(PL), MKEH(HU), VSL(NL), EIM(GR), SP(SE), DMDM(RS), CMI(CZ) |
| SIM     | K3   | Luminous Intensity | 2017 | CENAM, NIST, NRC, INTI, INMETRO |

### RMO Supplementary Comparisons in plan

<table>
<thead>
<tr>
<th>RMO</th>
<th>SC No.</th>
<th>quantity</th>
<th>year of measurement start</th>
<th>pilot</th>
<th>interested participants</th>
<th>remarks</th>
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<tr>
<td>APMP</td>
<td>S7</td>
<td>grey scale diffuse reflectance</td>
<td>2016</td>
<td>NIM (China)</td>
<td>NMIT, KRISS, ...</td>
<td>protocol in preparation</td>
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<tr>
<td>AFRIMETS</td>
<td></td>
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</tr>
<tr>
<td>COOMET</td>
<td>Sx</td>
<td>Colour, surface</td>
<td>2017 (?)</td>
<td>BelGIM (?)</td>
<td>VNIIOFI, NSC IM (Ukraine), KazInMetr...</td>
<td>Decision on start date will be made in 2017</td>
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<tr>
<td>EURAMET</td>
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<tr>
<td>SIM</td>
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### Time Schedule of 2\textsuperscript{nd}-round CCPR KCs

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<th>Meas. Start</th>
<th>Id</th>
<th>Quantity</th>
<th>Pilot</th>
<th>Status</th>
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<tr>
<td>2013</td>
<td>K6.2010</td>
<td>Regular spectral transmittance</td>
<td>MSL</td>
<td>Approved by WG-KC.</td>
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<tr>
<td>2014</td>
<td>K3</td>
<td>Luminous intensity</td>
<td>NRC</td>
<td>Pre-Draft A</td>
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<tr>
<td>2016</td>
<td>K4</td>
<td>Luminous flux</td>
<td>NMIJ</td>
<td>Protocol being developed</td>
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<tr>
<td>2016</td>
<td>K2.b</td>
<td>Spectral responsivity 300 nm to 1000 nm</td>
<td>KRISS</td>
<td>Meas to start</td>
</tr>
<tr>
<td>2016</td>
<td>K2.a</td>
<td>Spectral responsivity 900 nm to 1600 nm</td>
<td>NPL</td>
<td>Meas to start</td>
</tr>
<tr>
<td>2017</td>
<td>K1.a</td>
<td>Spectral irradiance 250 nm to 2500 nm</td>
<td>VNIIOFI</td>
<td>Protocol July 2016</td>
</tr>
<tr>
<td>2017</td>
<td>K5</td>
<td>Diffuse spectral reflectance</td>
<td>MIKES</td>
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<tr>
<td>2018</td>
<td>K1.b</td>
<td>Spectral irradiance 200 nm to 350 nm</td>
<td>NIST</td>
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<td>2019</td>
<td>K2.c</td>
<td>Spectral responsivity 200 nm to 400 nm</td>
<td>PTB</td>
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<tr>
<td>2019</td>
<td>K2.d</td>
<td>Spectral responsivity 10 nm to 200 nm</td>
<td>PTB</td>
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Reports from Task Groups

TG1  Task Group on pilot comparison for spectral regular transmittance in UV
Chair: Natasha Nel-Sakharova (NMISA)
- Protocol being developed.
- 200 – 400 nm
- 3 sets of metallic neutral density filters
- 7 levels of optical densities
- Panned participants: NMISA, NPL, NRC, PTB
- Measurements to start in spring 2017.
TG2  Task Group on RMO Linkage

Chair: Emma Woolliams (NPL)

- Most of the work was complete (Appendices in Guidelines G5 and G6)
- Prepare additional guidance for special cases (addressed in COOMET.PR-K1.b.1) to be added in Appendices in G5 and G6.
TG3  Task Group on Comparison Analysis  
Chair: Annette Koo (MSL)  
(changed from Emma Woolliams (NPL) in 2015)

TG held “Workshop on Comparison Analysis”, Oct. 2015, Beijing, chaired by E. Woolliams

<Focused topics>

• Politics and purposes of comparisons (support CMCs)
• models and solutions (fixed-effects model, etc.)
• Inconsistency in comparison results (e.g., outliers)
• Linking regional comparisons
• Checking consistency between CMCs and KC results
Conclusion of the Workshop

Create a Task Group to develop a new appendix for G2 providing guidance on the fixed-effects model and on least-squares techniques to be possibly used in CCPR comparison analyses.

This Task Group was established at WG-KC meeting in 2015. Members: MIKES (E. Ikonen), PTB (L. Werner), NPL (E. Woolliams), MSL (A. Koo), NIST (Y. Ohno) and NIM (Y. Lin).
Discussion of TG3 in 2016

• A draft of Appendix for G2 on the GLS models was developed by A. Koo. This will be further reviewed and to be published as a revision of Guidelines G2.

• TG will develop a proposal for revising G2 and Appendix to explicitly refer to fixed effects model by the end of 2016.

• Need for further research on this topic was emphasized.

• WG-KC agreed to organize a Workshop on Models for Comparison Analysis at an appropriate opportunity in 2017 (preferably at the time of NEWRAD 2017).
TG-4 Pilot study for the use of alternative standards for photometric comparisons
Chair: MIKES (E. Ikonen)
Members: MIKES, KRISS, LNE, MIKES, MSL, NIST, NMIJ, NRC, PTB

Investigate alternative transfer standard artifacts (white LED sources, LED lamps) for use in the future CCPR and RMO photometric comparisons (K3, K4).

TG started collecting information of recent research by member NMIs.
New EURAMET Guidelines on Comparisons conflicting CCPR Guidelines

There are critical differences in procedures between this new EURAMET Guide and CCPR Guidelines on Comparisons. e.g.

- Participants need to sign a commitment form.
- Time (2 months) from completion of measurement to Draft A distribution. EURAMET guide does not allow Pre-Draft A process – a very important process agreed in CCPR.

WG-KC proposes that CCPR starts official communication to EURAMET to resolve this conflict. → Decision by CCPR requested.
WG-KC has near-final draft of:
CCPR-G7 Draft Guidelines for RMO PR Supplementary Comparisons

The draft will be circulated to WG-KC members for final check, and to be submitted for CCPR approval by end of 2016.
Next meeting of WG-KC

We propose two and half days for WG meetings right before NEWRAD 2017 in Tokyo, including a full-day WG-KC meeting and a half-day Workshop on Models for Comparison Analysis.