Consultative Committee for Length – CCL

WORKING GROUP ON DIMENSIONAL METROLOGY – WGDM

11-12 September 2007 **Working Group Meeting No.12** BIPM, Sèvres

Approved Minutes of the 12th Meeting of the CCL-WGDM

Andrew Lewis, Rapporteur – 12 September 2007

The CCL's Working Group on Dimensional Metrology held its 12th meeting at the BIPM, Sèvres, on the 11 and 12 September 2007, convening at 09:07 on 11 September and closing at 15:00 on 12 September.

Executive:

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Rapporteur:

Andrew	**Lewis**	NPL	(UK)	EURAMET, CCL-K2 & DG3 (long gauges)	andrew.lewis@npl.co.uk

RMO/JCRB Representatives:

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Pedro	**Espina**	BIPM	(Sèvres)	JCRB	pedro.espina@bipm.org

DG Moderators & KC pilots:

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Other workers:

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Apologies for absence: Dr Peng (ITRI) had sent apologies for not being able to attend.

Day One, 11 September 2007

The meeting convened at 09:07.

0. Distribution of documents

Several documents had been distributed by Dr Vitushkin before the meeting via the WGDM area on the BIPM website. Herein, these and other documents will be cited by the abbreviated form [07-xx]. During the meeting several presentations were made and there was a request for **all presenters to forward copies of their reports (if not already sent or given to the Rapporteur) and any presentations, to Dr Lewis, for numbering and subsequent placement on the WGDM web site**.

1. Welcome

1.1 Welcome

The chairman welcomed the meeting. Dr Wallard, BIPM Director, welcomed the delegates and guests and mentioned that there were many issues to be discussed and decided upon and that this was a very important meeting of the WGDM.

1.2 Welcome of new members

The chairman welcomed new delegates and guests: Dr Matus (BEV, Vienna) – new TC-L chairman in EURAMET and pilot of CCL-K11, Dr Giardini (NMIA, Australia), Dr Balsamo (INRIM, Italy), Mrs Mostert (NMISA, South Africa).

2. Adoption of the agenda

The chairman tabled the agenda. There was one minor correction before the agenda was adopted.

3. Minutes of the last meeting

3.1 Corrections to and approval of the minutes

The chairman reported that the last version of the minutes from 2006 was Draft 4.2. Only minor corrections had been received since version 4.2. **Dr Lewis agreed to issue the minutes, via the chairman, as a final version** and **Dr Vitushkin would make them available on the WGDM web site**. The chairman thanked Dr Lewis for acting as the rapporteur of the previous meeting and agreeing to report on this meeting.

3.2 List of actions

The rapporteur polled the meeting for the latest situation on the progress of the Action items [A.1 to A.27] from the previous meeting.

No.	Action	Status
A.1	**All presenters** to forward copies of their reports (if not already sent) and any presentations made at the meeting, to Dr Lewis, for numbering and entry to the WGDM web site.	**COMPLETED**
A.2	**Dr Lewis** to renumber and consistently re-title the documents before collecting together for the website.	**COMPLETED**
A.3	**Dr Lewis** to formally issue the approved minutes of the 2005 meeting, **via the Chairman**.	**COMPLETED**
A.4	**Dr Vitushkin** to place the 2005 agreed minutes on the website.	**COMPLETED**
A.5	**Dr Peng** to add to the APMP.L-S2 report a pair-wise E_n analysis of the results or a demonstration that the chosen analysis is equivalent to pair-wise E_n analysis.	**COMPLETED**
A.6	**WGDM Chairman** to email the edited APMP.L-S2 report to the WGDM for approval.	**COMPLETED**
A.7	**WGDM Chairman** to add Dr Matus to the WGDM email and contact lists, copy recent WGDM documents to Dr Matus, and to specifically invite him to attend the next WGDM (and CCL) meetings.	**COMPLETED**
A.8	**Dr Kruger** to perform a new calculation for the 5 minute block and prepare a final version of the report. After the report is prepared, Dr Kruger to continue discussion with the participants, pursuant to sending the Final report to the WGDM within the year, and then preparing an Executive Report.	**COMPLETED**
A.9	**Dr Stoup**, after waiting for comments from participants, to finalise the latest version of the K4 report, which was approved at the meeting, and send to the Chairman for onwards transmission to the KCRB.	**COMPLETED**
A.10	**K4 comparison participants** to send corrective action responses to Dr Stoup before the end of December 2006.	**COMPLETED**
A.11	**Dr Stoup** to prepare the Executive Report on the K4 diameter comparison. This report to include the corrective action list from A.10.	**COMPLETED**
A.12	**All participants** to note the new email address of Dr Prieto (see page 1).	**COMPLETED**
A.13	**Dr Viliesid** to complete his existing evaluation of the K6 comparison and to prepare a final report and for distribution to the WGDM via the Chairman. Dr Viliesid to reduce the pilot laboratory influence by including only the first result from CENAM.	**COMPLETED**
A.14	**Dr Wilkening** to communicate to Dr Jusko the simple analysis approach being used for CCL-K6 and to ask Dr Jusko to continue with the preparation of the Draft B report on EUROMET.L-K6 in a similar manner. Dr Jusko to note the suggestions of Dr Schwenke on presenting the analysed data.	**COMPLETED**
A.15	**Dr Oliveira** to consult with SIM TC-L to progress their planning of their K8 roughness comparison.	**COMPLETED**
A.16	**DG8 comparison participants** to send comments to Dr Matsumoto by the end of December 2006.	**COMPLETED**
A.17	**Dr Matsumoto** to prepare a Final version of the report on the expansion comparison, to include data from CENAM, and to send this to the WGDM, via the Chairman.	**AGENDA ITEM**
A.18	**Dr Lewis** to report on the postponement of the K3 angle comparison to	**COMPLETED**

	EUROMET.	
A.19	**WGDM Chairman** to prepare a document for the CIPM on the comparison situation in CCL.	**UNDERWAY**
A.20	**WGDM Chairman** to apply to CIPM to be allowed to make a presentation on the CCL comparisons.	**ALTERNATIVE FOUND**
A.21	**Dr Vitushkin** to assist the WGDM Chairman in making approaches to the CIPM, where possible.	**ALTERNATIVE FOUND**
A.22	**WGDM Chairman** to send the latest DimVIM to the KCDB coordinator and negotiate a newer presentation format for the DimVIM on the KCDB website.	**COMPLETED DURING THE MEETING**
A.23	**Each RMO TC-L** to discuss the monitoring of CMCs after key comparison reports are published and to find their own solution to the question of how to monitor their NMIs' CMCs.	**AGENDA ITEM**
A.24	**Dr Lewis** to complete his previous report/paper on the use Executive Reports and CMC monitoring.	**COMPLETED**
A.25	**WGDM Chairman** to raise the K11 issues with Dr Chung and Dr Wallard.	**COMPLETED**
A.26	**Ms Tan** to send to WGDM, when available, details of the Nanometrology conference (planned to take place in Singapore in October 2007).	**COMPLETED**
A.27	**All participants** to send corrections and edits on the 2006 minutes to the Rapporteur.	**COMPLETED**

On action A.23 Dr Wallard responded that there had been some discussion at the JCRB on how the RMOs would report this.

4. RMO reports

4.1 APMP

Ms Tan presented her report [07-25]. Dr Signhal, the previous TC-L chairman had stood down recently on retirement from NPL India and Ms Tan, who had recently been elected as the Vice Chairperson, had taken over the post of TC-L chairperson. APMP.L-K1 had been fully published on 2006. There was a follow-up comparison (APMP.L -K.1.1) piloted by NIJ and Draft A was in preparation. APMP.L -K2 was published in 2006. APMP.L -K3 started in 2005 and circulation is coming to an end in a few months. There had been a loss of data and this was being worked on. APMP.L -K4 was piloted by NMIJ, had fourteen participants and would start in 2008. The 1-D CMM artefacts comparison was being piloted by KRISS (PTB had withdrawn due to closure of service). APMP.L-K6 was piloted by NMIJ and was expected to finish in early 2008. APMP.L -K11, piloted by NIM, was published in August 2007. APMP.L-S2 was a bi-lateral PTB-NMIJ on pitch standards and was now posted. There was detailed planning on a Surface Roughness comparison to be piloted by Dr Baker in NMIA. Contact with NIS was difficult and **anyone with reliable contact details for NIM, Egypt, should contact Ms Tan with details to pass to Dr Baker**. It was uncertain what was happening with the CMCs from NPL-I and NMISA.

APMP member KIM-LIPI assisted by KRISS, had a programme running to help developing economies and they had been running a gauge block comparison.

There was a planned joint workshop between the CCL and CCTF on optical frequency standards. Website for APMP TC-L activities: www.nml.org.tw/apmptcl/ (password for downloads: apmptcl2004).

It was noted by the KCDB manager that the K4 and K6 comparisons had not yet been registered in the KCDB.

4.2 COOMET

Dr Fira presented his report [07-26] on activities in the COOMET region. Now, seventeen countries are listed as COOMET members, two new members Armenia and Azerbaijan had joined recently. The secretariat and president were provided by Ukraine. There are 9 agreed projects and the majority have been running for several years. One project was completed in the last year on internal diameter and its project report was published in the journal 'Izmeritelnaya technika'. A new project on straightness and flatness had been started. Moldova had its CMCs reviewed in 2006. Three COOMET countries' CMCs are listed in Appendix C, other than those submitted via EUROMET. It had been noted that some CMC items were not yet supported by comparisons.

4.3 EUROMET

Dr Lewis presented the report for EUROMET/EURAMET [07-27]. He reported first on the change from EUROMET to EURAMET e.V. which was now a legal entity. This was done to allow EURAMET to operate a new European Metrology Research Programme, partly funded by central European funds (EC). The change of name and status would mean little difference to CCL/WGDM interactions with EUROMET. The CIPM had now recognized EURAMET as the RMO for Europe. However, the workload in preparing the EMRP means contact persons are quite busy until the end of the year. Overall project participation had dipped slightly in the last year, though the number of active projects had increased slightly. EURAMET was running 3 of the CCL-RMO comparisons and had recently seen a new set of CMCs enter the KCDB. A new set was being collected but their internal EURAMET review would be delayed until after the EMRP workload had decreased. Dr Lewis had stood down from TC-L chairmanship at the end of the usual 4 year period. Dr Michael Matus was the new chairman and Dr Lewis asked the WGDM to welcome him and extend the usual kindness and help.

4.4 SADCMET

Dr Kruger gave his presentation [07-28] from the SADCMET region. The Third WG chair meeting was to be held in November 2007 to discuss problems of the comparisons. Accreditation of SADC NMIs in certain areas, including length, is currently a top priority. SADCMET.L-S1 on measurement of 9 gauge blocks (3 steel, 3 tungsten carbide, 3 ceramic) by comparison is being planned. The NMISA Gauge Block Interferometer had developed a problem but was fixed in the year. Five countries will participate, three others may take part depending on equipment and laboratory environment. There was also a plan to start a line standard comparison. This is a subject which is important as line standards are mainly used for trade metrology purposes. Four laboratories had agreed to participate and another three were hoping to take part.

4.5 SIM

Dr Oliveira gave his presentation [07-29] covering the period of Nov 2006 to Sept 2007. The report for SIM.L-K1 on small gauge blocks, piloted by NRC, was approved and published in the KCDB. SIM NMIs were taking part in EUROMET.L-K5.2004 step gauge comparison and in the EUROMET.L-K4.2005 comparison on diameter measurements. It also had NMIs taking part in the line scale comparison EUROMET.K7.2006, though there was a delay due to customs. INMETRO and NIST were taking part in APMP.L-K5.2006 step gauge (620 mm) comparison.

A comparison on roughness standards was being planned, piloted by NMIA and NIST will make measurements in January 2008. SIM has reviewed the set of CMCs EUROMET.L5 and these had been published. SIM had made no new CMC submissions itself during the period, though there had been a fast track set of changes related to NRC gauge block CMCs, based on changes to uncertainties due to different material types. SIM is planning K1 and LS1 comparisons (gauge blocks by interferometry and mechanical comparison) and a pilot study. The planned start was October 2007.

Comparison SIM.L-K3.2007 on angle blocks and polygons was being prepared. The protocol is in preparation and the circulation was planned to start soon. SIM.L-S2.2008 is a comparison on roughness standards, piloted by INTI. The protocol is expected by end October 2007. Artefact circulation was planned to start in March 2008. The SIM.L-K4.2007 comparison on ring and plugs is being piloted by NIST. A protocol is being prepared. Circulation will probably start in Nov 2007.

Dr Oliveira also reported on a dimensional metrology training course which will take place in Oct 2008 at INMETRO and on a mechanical metrology congress, CIMMEC, to be held in Rio on 8-10 October 2008. Details would be available from the website www.inmetro.gov.br/cimmec .The Sunday-Tuesday before the Congress (which starts on Wednesday 8 October) was offered as a possible venue for the next WGDM meeting. However the meeting venue would be 60 km away from the INMETRO, so there would be some planning issues.

The chairman noted the NANOSCALE 2008 conference at INRIM, Torino, had also been offered as a potential venue for the next WGDM meeting. NANOSCALE would run over 22-23 September 2008 and 24-26 September would be available as a possible WGDM meeting date.

Ms Tan also reported that there would be a laser metrology symposium running over 30 June – 2 July in Singapore [07-38-2] and this was offered as an alternative WGDM meeting venue for next year.

The chairman thanked all the RMO representatives for their reports and also for the kind offers for hosting the next WGDM meeting, He felt it was still important to see the work of the various regions and valued the opportunity for WGDM members to visit NMIs that they might otherwise not have the chance to see.

5. MRA activities

5.1 Report on JCRB activities

Dr Espina reported [07-21] on the work of the JCRB throughout the previous year. The JCRB had been very active and had been represented at many meetings. There was a new document on the review of quality systems, CIPM-2006-03. It requires the involvement of a panel of experts from all the RMOs. The document was used for the review of the IAEA in October 2006. Their QS was approved. The BIPM will present its QS to the panel in March 2008 and will make its uncertainties more visible on the BIPM web pages.

A new document, CIPM-2006-05 gives recommendations for on-site visits by peers and the selection criteria for visiting reviewers. The document was recommended by the JCRB to the CIPM for consideration in November 2007. A web based document acting as a guide to the operation of the MRA, useful to TC-L chairpersons, had been prepared which would contain hyperlinks. The guide should be available for CIPM approval late 2007.

It had been discovered that many NMI staff do not understand how to use the CIPM MRA. A series of world-wide seminars are being planned to aid new NMIs with their participation in the MRA. The first workshop, in South Africa in May 2007, had been attended by LACOMET, DZM, NIS, KazinMetr, KEBS and VMI. Two of the participants had subsequently submitted CMCs and others were well on the way to submitting CMCs.

The 18th JCRB meeting had resulted in a number of actions:

Action 18/1 – RMOs to monitor changes to CMCs after results of comparisons are published.

Action 18/2 – RMOs asked to provide information on designated institutes to BIPM director

Action18/3 – RMOs to remind TCCs of Executive Secretary of CCs shall be informed in advance of all comparisons using the form available from the JCRB website. The Executive Secretary will forward the form to the KCDB office.

Action 18/4 – RMOs to remind NMIs and TCCs to use the 'get published Excel table' on the JCRB CMC review website when making changes to CMCs or submitting new CMCs.

Action 18/5 – JCRB was establishing a WG to revise its rules and procedures. RMOs have supplied list of issues by June 2007. The JCRB will move to a more formal process for operating its meetings.

Non-TCC access is allowed to the JCRB CMC review website, username is 'tcguest' and password is 'tcontact'.

JCRB Executive Secretary ends his term in Spring 2008. There are 3 candidates who have applied for the post. Dr Espina thanked the WGDM for all their interactions and help during his term. The chairman thanked Dr Espina for his work with the WGDM, especially the work in recent weeks on preparing for the WGDM meeting.

Dr Thalmann reminded everyone that not only CMC changes happened after the results of key comparisons were published, but there were also corrective actions that had to be performed. He also asked the **TC-L chairs to remind their members of the JCRB CMC Excel file access information because this was important.**

5.2 DimVIM updates

Dr Pekelsky had not tabled a report as there had been no changes to the DimVIM (the length CMC categorisation scheme) since the previous WGDM meeting. Dr Kim had presented Dr Pekelsky at the start of the meeting with a new language version of the DimVIM in Korean. The Chairman showed the new translated page. **The chairman asked Dr Pekelsky to discuss with Dr Thomas and Janet Miles the best way to present the multi-language DimVIM and to improve its visibility. The chairman also agreed to send a copy of the latest updated DimVIM to Dr Lewis to go onto the EUROMET website.** Dr Lewis responded that the latest DimVIM was available in several languages from the EURAMET TC-Length website (www.npl.co.uk/euromet/length/dimvim.html).

The chairman informed the WGDM that there were some new responsibilities assigned to the WGDM to take care of the CMCs for frequency standards, in particular those need for fs comb laser calibrations. These would need to enter the DimVIM. **Dr Pekelsky took an action to obtain the fs comb CMC information from the CCL-CCTF joint working group and create the new CMC categories in the DimVIM.**

The chairman welcomed Dr Steele who had just arrived.

The meeting broke for coffee at 11:03 and resumed at 11:27.

6. Linking KC by statistical consistency

The chairman reminded the meeting of the previous discussions on how to link key comparisons. There had been some presentations and discussion at the previous WGDM meeting. He welcomed Dr Steele who then made a presentation on the linking. This was based on a paper that had been submitted recently for the WGDM meeting [07-04] and which was to be submitted for publication in *Metrologia*.

The mechanism adopted at the previous workshop was reviewed as the basis for the analysis of a single comparison. The linking from the CCL comparison to the RMO comparison was described. The additional step of linking meant that there was not as fine a resolution in testing the degrees of equivalence of the RMO comparison members, but there was no disadvantage to these NMIs' CMC claims.

The unmediated (all pairs difference) was examined and shown to be equivalent to the traditional chi-squared analysis. This could be used to examine the consistency of groups of laboratories including the laboratories that took part in multiple comparisons. If their performances are consistent, then there is a valid argument for linking. Three linking mechanisms can be used:

- comparison reverence values;
- difference in the linking lab mean values;
- mean of the linking lab differences.

The first two techniques had disadvantages and the third had an advantage:

- 'Linking via the KCRVs' is flawed because the test for statistical consistency is based on the assumption that the labs agree with other – which is a circular argument.
- 'Difference in the linking labs means' employs consistency testing but is flawed because it assumes a common mean which implies a single population assumption. It also requires a stationary measurement uncertainty of each linking laboratory.
- 'Mean of the linking lab differences' assumes each linking laboratory has maintained its capabilities without drift, which is usually a good assumption to make.

Linking is performed by a consensus invariant. This linking does contain an additional uncertainty, as this is unavoidable.

The uncertainty in the linking invariant can be calculated and reduced through careful stability control of equipment and processes. For linking using gauges of different sizes, the uncertainty due to the size difference can be worked out based on the uncertainty budgets. An example graph was shown for the CCL-K1 comparison, with linking into the SIM.L-K1 comparison. The error bars for the SIM (non-CCL) participants had widened a little due to the linking uncertainty. Also on the graph was data linked into the EUROMET comparison. Here, due to the small uncertainties of the EUROMET data, the uncertainty bars were not visibly extended, i.e. there was not significant increase in the uncertainty of the plotted result. So, for this example, there was no difference in the results status for the EUROMET data even though it was linked into by the CCL data.

The chairman thanked Dr Steele for the presentation. He was pleased to see that although the uncertainty of the reference value was inevitably increased by the linking, this had no negative effect on the CMC analysis and thus the status of the RMO comparison was not degraded. However he reminded the meeting of previous issues that had been discussed about the difficulty in linking the more difficult comparisons such as the ISO roughness profile calculations. There were also some problems in linking the gauge block comparisons due to systematic offsets that were difficult to determine (e.g. phase correction).

In the CCL-K1 comparisons, there had been discussions with the KCDB manager about the linking process based on the nominal length of the gauge block and the possibility of additional rigor provided by using statistical consistency within each comparison or across the linking laboratories was an advantage over the previous 'expert judgement' that had been used. We could then choose whether to use a calculated numerical link, as presented by Dr Steele, or, for the more difficult comparisons, to check consistency and decide on linking by consistency.

Dr Wallard asked Dr Steele if there was a minimum number of linking laboratories which could provide a viable link. One was the minimum needed for MRA purposes, but this requires very good stability of the lab and detailed knowledge of its uncertainties. Two linking laboratories allows for some statistical calculation for checking. For three laboratories, there is reasonable improvement but the improvement goes as the square root of the number of labs. Dr Giardini asked about how the statistics worked when the number of linking laboratories was one. There was a problem in obtaining statistics in this case and

there was an issue about whether or not this was really a statistical link. Dr Viliesid asked about the reason why the SIM laboratories' results had been worsened by the linking. The reason the results in the SIM region were not as good as in CCL or EUROMET was due to the fact that the expansion coefficient had not been supplied in the SIM comparison.

Dr Matus asked about how similar the artefacts should be. Dr Steele responded that it was possible to link across different sized artefacts, provided that the differences between gauge block length measurements made by the participants was stable, i.e. if NPL measures a 95 mm gauge in one comparison and a 100 mm gauge in another one, provided the difference in the lengths measured by NPL is accurately determined (through cancellation of some uncertainties), then the link can be made. Ideally avoid making the difference in size too great to avoid creating additional uncertainties.

Dr Brown was concerned about having to continue the double-effort required by running the central CCL comparison as well as the RMO comparisons. The CCL-RMO comparisons were working well now as the CCL members were taking part in the RMO comparisons knowing that they did not have double effort to take part in the CCL comparisons as well. He hoped that the CCL-RMO comparisons could continue without the additional workload of the CCL comparisons. Dr Steele responded that for top level CMC services, comparison participation is mandatory and there is a need to link these across regions and this explicitly requires laboratories taking part in more than one comparison. He thought that the CCL-RMO comparisons were truly inter-regional and were CCL comparisons in all but name. He recommended to reduce the number of key comparisons and to really concentrate closely on the issue of what are the key techniques.

The chairman thanked Dr Brown for the comments on the success of the new style comparisons. He thought a way to progress this work (linking comparisons and deciding on the portfolio) could be the work of a small group. This would be decided in a later agenda item.

The chairman asked Dr Steele for permission and then took copies of his presentation and Excel files to be placed on the website.

7. CCL-WGDM position paper on key comparisons

7.1 CCL-RMO comparisons & 7.2 Linking CCL KCs

The Chairman mentioned that this would be the most difficult topic of the meeting. The structure of the discussion would not follow exactly the tabled agenda headings. He reminded the meeting of the CIPM questions raised at the previous meeting and the responses that the WGDM had decided upon very soon after the meeting.

Since then, there has been several communications between the chairman and the JCRB secretary and some changes had been made to the documents produced, including a recent edit just before the WGDM meeting. He presented the latest version of the document giving responses to the CIPM concerns. He went through the individual responses and opened the discussion. Dr Espina tabled some suggested changes to the document and **Dr Lewis agreed to update the document.**

Dr Wallard mentioned that the discussion seemed to have made progress, particularly in the last few weeks. The CIPM had not been convinced about the arguments about non-linking but were aware of the issues of overloading of work in key comparison participation. However, many CIPM members expected that NMIs that were members of the Consultative Committees should take part in CC key comparisons, as this was one of the duties of being a Consultative Committee member. Dr Wallard suggested that the way forwards was not to present this discussion directly to the 2007 meeting of the CIPM via the CCL President or via the BIPM Director, but to continue this as a work in progress and to work towards a paper to be published before the 2008 CIPM. He recommended a review of the comparison workload by looking at what topics were really key and to maximise the CMCs that were supported by the key comparison portfolio. The issue about the regularity of the WGDM meeting at the BIPM had been raised because it is helpful for dialog that BIPM staff can attend the meeting, as well as perhaps the CCL President.

The chairman thanked Dr Wallard for the responses and asked him to assure the CIPM that WGDM was addressing the issues. Dr Thomas' personal feeling was that the new term 'CCL-RMO key comparison' was perhaps unfortunate. The CCL meeting 2003 report mentioned at page 32 that these 'may' be called CCL-RMO key comparison. Dr Brown responded that the wording had been very carefully chosen and the term 'CCL-RMO key comparison' had been arrived at after lengthy discussion with Dr Quinn (who was the BIPM Director at the time) during a meeting preceding the 2003 meeting of the CCL.

Dr Espina requested a summary of the agreed way forward. The chairman said that **the [07-06] responses document would be placed on the WGDM web server** and so it would be available for the CCL President and also the CIPM to read. **Dr Wallard agreed to ensure that the CIPM was aware of the document.** The more detailed paper, to be co-authored with the BIPM**,** would follow later.

The meeting broke for lunch at 13:15 and resumed at 14:00.

Dr Wallard clarified a comment made earlier about the duties of Dr Arias with regard to the various committees. He clarified that Dr Arias is head of a group within the BIPM and takes care of CCTF and CCL, and is the Executive Secretary of the CCTF. However, it is Dr Felder that is the CCL Executive Secretary.

The chairman presented the latest version of the 'Position paper' [07-01-1]. This had been edited since the version tabled before the meeting, that document having been split into three documents: the responses to the CIPM [07-06]; the portfolio of key comparisons [07-05]; and a paper yet to be written but using as a basis the latest version of [07-01-1].

The presentation included a revised version of the CCL-RMO comparison scheme, showing overlapping RMO comparisons – the overlap being by NMIs that take part in either their own region, or in another region's comparison or perhaps in all RMO comparisons. The diagram, being 2-D could not show the important 3rd axis which is time. The comparisons would be organised to happen at different times. This was in fact not different from the classical CCL and RMO key comparison scheme, where a delay of several years between the CCL and the CMO comparisons was common, with up to 7 years delay between the CCL comparison and the corresponding RMO comparison.

The scheme had many advantages: lower cost, more flexibility for specific regional needs, reduced workload for CCL members, avoiding making the RMO comparisons seeming 'lower level', and the possibility to run comparisons at different uncertainty levels.

Dr Thomas asked how a KCRV could be calculated from such a scheme, in cases where it was deemed that a KCRV was a useful output from the comparison. According to the MRA, only a CCL comparison could produce a key comparison reference value. Was there a way of interpreting the proposed scheme as actually being equivalent to a CCL key comparison? Could the laboratories that were in more than one comparison, if they were CCL members, be considered as being part of some 'CCL comparison'? There was a discussion on the history of the proposed scheme, including the problems of communicating the ideas to those outside the WGDM. The chairman asked the group to make progress forwards and not to keep returning to history. If the problem was just a matter of semantics, then we should fix it and that was one of the reasons for working on the detailed document. Dr Vitushkin reminded the meeting of his point from the previous meeting – the comparison was a comparison of measuring instruments and techniques – the results were obtained using travelling standards such as gauge blocks, but the results and the KCRV relate to the instruments. The only exception may be the laser comparison, since these are national standards that are compared.

Dr Pekelsky asked for clarification on the point of the overlapping laboratories. If these were CCL members, would it be acceptable for the other members in the regional comparisons to be non-CCL members? Dr Wallard agreed that it would be acceptable and this would be very similar to the classical

scheme of MRA comparisons. Dr Espina welcomed the discussion and commented that this new viewpoint was the start of the common paper between the WGDM and the BIPM. The joint authorship would mean that the paper would need to be in good alignment with the MRA. The chairman replied that this was correct - the document being shown had evolved from the position paper and is now just the starting point for the joint paper.

The meeting broke for coffee at 15:45 and resumed at 16:10.

7.3 CCL key comparison portfolio

The chairman reviewed previous discussion on key comparisons. He presented the overview of the comparison portfolio [07-05] and invited comments on whether topics were considered key or supplementary. Tabled were K11 (Mise en Pratique lasers), K1 (gauge blocks up to 500 mm), K3 (angle standards), K4 (cylindrical diameter standards), K5 (step gauge), K7 (line scales), K8 (roughness). The last meeting had showed many opinions and it was not clear what was the consensus.

Dr Wallard mentioned that a CIPM working group was due to report soon and this included materials measurements. Roughness seemed to be a parameter that was similar to parameters they were involved with and there may be overlapping work or opportunities for improved traceability. Dr Wilkening supported the elevation of K8 to a key comparison topic as roughness was one of the more frequently measured items, also at the nano scale. It was also a topic where there was currently a lot of work in terms of standardisation, improvements in measuring equipment. Dr Oliveira wished to extend the scope of the K8 subject to encompass more types of standards, not just roughness, but also step height standards. Dr Lewis cautioned on extending the set of key comparisons too far and pointed out that in many of the classical comparisons run so far, the artefacts had been shown to suffer damage or to be unstable. Were the comparison topics fitted around the best available artifacts? Dr Takatsuji asked about including the various form parameters such as roundness, flatness, cylindricity. Dr Giardini noted that the majority of the key comparisons were uni-dimensional, and that form measurement was an extension to other dimensions, and this was not always easy.

Dr Lewis reminded the meeting that on the 7 year repeat cycle, we should have started artefact circulation on the repeated CCL-K1 comparison about 3 years ago. Even on an extended 10 year cycle, the comparisons should be being repeated already. He asked if there were CMC reviewers who found CMCs that could not be supported on the current portfolio of key and supplementary comparisons. There were none cited.

Dr Bergmans suggested the use of gauge blocks of the most stable and durable materials, rather than sending gauges of many materials, in order to test the service, rather than the artefacts. It may also be useful to circulate in separate regional comparisons, gauges of different materials, e.g. a ceramic comparison, a tungsten carbide comparison.

The chairman summarised that the comparisons shown in the table (and described above) were agreed to be key comparison topics and that we did not wish to add to the list nor subtract from it at this time. The title of K8 was changed in surface texture standards. The meeting was in agreement.

7.4 Schedule of CCL and CCL-RMO Comparisons

This item was not discussed and was postponed until the next meeting, by which time **the chairman would have had time to prepare a schedule of completed and running comparisons.**

8. CCL guidance document on corrective actions

Dr Lewis tabled the latest version of a document concerning the process of deciding on and reporting on corrective actions following the publication of MRA comparison reports [07-41]. The chairman

thanked Dr Lewis for preparing this document which he considers to be an internal guidance document for use within WGDM and the RMO TC-L community. He encouraged the TC-L chairpersons and key comparison pilots to make use of the document. **Dr Lewis would examine the document after the JCRB had produced its online summary of the MRA processes**.

9. Issues related to CCL-K11

9.1 Traceability issues in length

The chairman reminded the meeting of some questions that had been raised at the previous meeting concerning the CCL-K11 comparison that was to continue after the end of the BIPM,L-K11 comparison. Dr Brown gave his presentation [07-40-B]. Depending on which of the three methods, listed in the *Mise en Pratique*, was chosen for the wavelength realisation, traceability could be to either the primary wavelength standards or to the SI realisation of the second. Previous comparison BIPM.L-K10 used the wavelength of the BIPM4 laser as the KCRV. For the next comparison, BIPM.L-K11, there was no key comparison reference value used. Therefore, since the upcoming CCL-K11 comparison is based on the protocol of BIPM.L-K11, it too does not have a KCRV defined. Now that the laser wavelengths were the responsibility of the joint working group of CCL-CCTF, the question arose as to which group was responsible for the traceability routes since these could be traceable to the primary wavelength standards or to the second.

The meeting of the Joint Working Group (JWG), which had met on the previous day, had decided to maintain the common list of radiations. Depending on their use, the JWG would recommend new radiations to either CCL or CCTF. Responsibility of coordinating the CMCs for laser frequency calibrations would be managed by WGDM, the JWG will take responsibility for K11 including the protocol and the planning. If the WGDM needed technical help when defining service categories, it would ask the JWG. An outstanding issue was whether or not CCL-K11 is a calibration or a comparison? If a calibration, then a certificate should be issued and the calibrated laser was then a secondary standard, traceable to the second. If a comparison, the laser was still considered primary and useable as a national primary standard of realising the metre.

Dr Vitushkin was of the opinion that a measurement of a laser frequency by a comb was a calibration, and direct comparison of two laser frequencies was a comparison. Dr Steele mentioned that the decision of NRC to operate as a node was based on the operation of CCL-K11 as a comparison, and not as a calibration. Calibration of lasers was available from NRC (and other NMIs) as a well known service. Dr Wallard mentioned that the meetings of the CCL and the CCTF would, in future, be aligned so that issues and outcomes of the JWG would be reported to their relevant Consultative Committee.

The JWG would be asking the CCL to view the joint list of frequencies, and express its opinion as to which values the CCL wished to approve as recommended radiations for length measurements, to be put as a subset of the joint list in a separate appendix.

9.2 Running CCL-K11

Dr Matus mentioned that in EUROMET one of these local nodes was already active, and MIKES was already offering this service, based on the K11 protocol. The chairman asked what was now necessary for an NMI with both primary lasers and a fs comb. Did it have to take the laser to a node for comparison, or was internal use of its own fs comb enough to check the laser operation? This was not yet clear and this would be asked of the JWG.

10. WGDM business

10.1 NRC proposal on structure of CCL working groups

The chairman asked Dr Pekelsky to present the proposal made by NRC on re-structuring of the working groups of the CCL [07-03]. Dr Pekelsky reminded the meeting of the history of the WGDM which had been formed at the 8th CCDM meeting in 1992. The WGDM met first in 1996 and it had met every year since then. From the very start, the WGDM had been asked to consider key comparison topics. It had then continued over the years to undertake pioneering work on the MRA activities, such as the DimVIM, CMCs, key comparison planning, strategic planning and so forth. However this work had not been communicated well outside the working group as many were not aware of the work of the WGDM. Also, the scientific work normally discussed at CCL was being handled within the WGDM and WGMeP. It had seemed that it was time to revisit the structure of the CCL working groups. The outline plan was presented and was based on a large number of Working Groups:

WG1 – lasers

WG2 – strategic planning

WG3 – WG9 – seven working groups based closely on the previous discussion groups

WG10 – key comparisons

WG11 – CMCs

The main changes, apart from the new groups, would be the promotion of the previous Discussion Groups of the WGDM into Working Groups of the CCL. This would give them greater visibility and accountability. It would also reduce the workload of the WGDM chairman.

The chairman responded with some comments and alternative proposals. He was cautious about changing a structure which had been so far efficient in its work. The Discussion Groups had worked well, when they were needed. WGDM is a small community and often the same people are involved in many activities (especially coming from the smaller NMIs). Concerns raised so far addressed to the CCL or the WGDM were not related to its structure. A small sub-group acting as a steering committee has worked effectively so far. But this could be opened further. An alternative proposal [07-03-1] was to maintain the WGDM and assign responsibility to task force or discussion group leaders for:

- Key comparisons (coordinating and linking)
- CMCs (coordinating the review, DimVIM...)
- Strategic planning
- Nanometrology
- Thermal expansion
- 1 DG for every topic

Task/discussion group leaders may form a steering group usually in charge of drafting working documents. Task/discussion groups are only active when needed and usually work by correspondence. When required they can meet in time slots during the WGDM meeting. Task/discussion group leaders report to WGDM. WGDM reports to CCL, rather than having the DGs directly, otherwise the CCL meetings would become very long, taking so many reports.

The chairman opened discussion. Dr Wallard commented that the items being presented followed many of the requirements asked of Consultative Committees by the CIPM. He felt that the move of the optical frequency experts of the CCL to CCTF was natural and was likely to happen. The proposals just discussed were leading towards a CCL which had a longer term view of the needs of metrology. This

strategic review should encompass the RMO roadmaps – taking a view as to overlapping work, gaps, direction. It seemed essential to set up MRA working groups to identify and take on this work in its own right. The WGDM had been doing this work up to now but the work was growing and needed better visibility. However, having individual groups on detailed technical areas could lack the commonality of something like the WGDM and one might consider having to set up something like the WGDM in the long term if it did not exist.

Dr Pekelsky thanked Dr Wallard for his responses and was pleased to see that they generally supported the proposed changes to the structure.

Dr Giardini commented that there was a real need for genuine working groups, i.e. that could achieve actual work. He wanted to see that the groups were set up carefully in order to guarantee the right mixture of people who could achieve real outputs.

The chairman was of the opinion that the proposed changes needed further consideration, especially as there were several other important issues that needed to be finalised with more urgent importance. Dr Pekelsky suggested that the two proposed models for future structures were so close that there was little discussion needed on this. He suggested that the two more important issues should be taken forward immediately by small working groups: linking of key comparisons, and the work on the position paper. He suggested that Dr Decker (or Steele) and Dr Brown would be key members of the group that would discuss linking of key comparisons. He left the membership of the second group open.

The meeting was adjourned at 18:41.

Day Two, 12 September 2007

The meeting re-convened at 08:34.

The chairman returned to the conclusion of the previous day's discussion on the two urgently needed task forces plus those that seemed to be common to the new proposed structures.

He confirmed that the task force on the linking of key comparisons would include Dr Brown and Dr Decker (NRC). He asked for additional members: Dr Giardini, Dr Viliesid, Dr Bosse volunteered. Others could approach the task force leaders (Decker, Brown) if they wished to join.

For the task force on how to run comparisons and to prepare the joint paper, Dr Espina had volunteered outside the meeting to join but in case of him leaving before the work is completed, the BIPM should be free to choose an alternative. The chairman offered to lead the task force. Dr Brown would be a useful link to the analysis task force, and Drs Lewis, Pekelsky, Giardini also volunteered.

Another task force to address the work on organising the key comparisons would comprise current DG moderators: Thalmann/Lewis, K3 - Kruger, K4 - Stone, K5 - Jusko, K6 - Viliesid, K7 - Bosse, K8 – Doytchinov (NRC – To Be Confirmed), K11 – Matus. If a chairmanship was needed, WGDM chairman would perform this role.

Task force on CMC review would be made from the RMO TC-L chairs: Matus (EURAMET), Fira (COOMET), Kruger (SADCMET), APMP (Tan), SIM (De Oliveira). Additionally membership would include the Executive Secretary of the JCRB, the CCL Executive Secretary and the KCDB Manager. The chairmanship of this task force would rotate and would start with Dr Oliveira with help from Dr Pekelsky.

Dr Balsamo asked if this was the official starting of these new groups, as discussed previously. Dr Thalmann said that this was the compromise position. The groups included those that were needed urgently and those that would be required for either of the new proposed structures. The formal structure would evolve when the structure of the CCL had settled down. Dr Balsamo welcomed common participation within the various groups as, for example, the overlapping between organizing comparisons and linking them.

Dr Oliveira asked for confirmation on the setting up of new DG on surface texture. This was confirmed but the numbering was not clear. The new and existing task forces/discussion groups would need a re-numbering.

10.2 WGDM terms of reference

This item was not discussed but implicitly covered in agenda item 10.1. Terms of reference would provisionally be those of [WGDM-07-02 TOR].

10.3 WGDM data base manager

This item was not discussed.

10.4 CCL long term plans

This item was covered in agenda item 10.1.

11. Key comparisons

11.1 K1 – gauge blocks

The time was approximately right to re-start the key comparisons cycle since it was now about 10 years since the original CCL-K1 comparisons. It was necessary to examine the status of all the key comparisons as there were several in the regions coming to and end and the CCL cycle 1 key comparisons were

Dr Matsumoto presented the traceability system for gauge blocks in Japan [07-31-1]. NMIJ had prepared an Etalon in the form of a quartz gauge block tightly wrung to a quartz platen. The gauge length was 100 mm and the expansion was about 0.3 x 10^{-6} K^{-1}. The gauge block was designed as a standard for checking gauge block interferometers, especially those that used spectral lamps since the traceability of these was not so easy to confirm. The gauge block had been measured by 15 laboratories and had been found to be very stable (about 10 nm length changes, randomly, between different measurements). The chairman said that the gauge was a good way of giving traceability (as it was used in Japan) but it was not so suitable for use as a key comparison artefact because it was different to client gauge blocks. Dr Bosse countered that this might be a useful artefact for obtaining scientific information about different gauge block measuring systems. Dr Viliesid said that the SIM K1 comparison that was about to start would include circulated platens.

11.2 K3 – angle

Dr Kruger had already tabled the final version of the Draft B report on the angle comparison, [07-32-1] and he gave a presentation on the comparison [07-32-2]. The report had used several ways of calculating the reference value, but the advice given in the WGDM 2006 had been followed for calculation of the final results. On the polygon the results were very good. For the angle blocks, the results were more variable. One of the blocks was deliberately chosen as it did not match the indexing positions on classical indexing tables. The Executive Report was being prepared and the pilot was awaiting two NMIs to provide explanations for deviations (VNIIM and CENAM). Dr Kruger asked if he had to try to link the comparison to the previous EUROMET comparison on polygons. The chairman responded that the linking was the job of the linking task force. Dr Kruger thanked the experts from NMIA and NIST for their help at the start of the comparison. The chairman thanked the pilot for the work on the comparison and noted that the final report had been circulated to the WGDM. The chairman asked the meeting to approve the final report. **It was approved.** The chairman asked **Dr Kruger to prepare the Executive Report and to send the Excel file of the results, including degrees of equivalence to the KCDB manager.**

Dr Bosse mentioned that many NMIs had services for the calibration of autocollimators and asked if this should be a topic for a comparison. The comparison task force should address this – maybe the comparison was only necessary at the regional level as a supplementary comparison.

11.3 K4 – diameter

Dr Stone mentioned that Dr Stoup, the pilot had previously tabled the final report on this comparison [07-33-1] and then went on to describe some issues from the Executive Report [07-33-2]. He highlighted some NMIs which had experience problems. He also mentioned that the pilots, Dr Stoup and Dr Doiron were about to start a SIM diameter comparison and **participants from outside the SIM region were invited.**

Dr Balsamo presented a short progress report [07-33-2] on the low uncertainty loop of comparison EUROMET.L-K4.2006. The artefact circulation is complete and data analysis has been started. There are some anomalous results (E_n > 2). Elimination of outliers is proceeding, with contact to the NMIs concerned. The other loop of the comparison, pilot by OMH was at a similar stage. The chairman asked **the RMO representatives to remind the pilots that Draft A does not require any analysis**, and can be simply a table of results.

11.4 K5 – 1D CMM artefacts

Dr Prieto gave his presentation [07-34-1] on the step gauge comparison. Final measurements were anticipated at CEM, the pilot, in October. The results showed changes indicating that some of the steps had moved. This was confirmed by results from other participants. There would need to be a detailed discussion on the way to perform the analysis. Dr Brown thought the movement of one step would not affect the others and the chairman responded that the design of this type of gauge had been recently improved by the manufacturer and this type of change was no longer likely.

Dr Kim presented his report on the APMP step gauge comparison [07-34-2]. There were 14 participants and the circulation was expected to be concluded within one or two months. Dr Kim remarked that the measurements by the pilot laboratory indicated that the step gauge was stable. Dr Thalmann mentioned that the METAS results had been sent again after a correction had been re-determined and asked that the revised results were used for the analysis. Dr Takatsuji cautioned the pilot that the ATA Carnet was about to expire so the revision of the timetable to include Hong Kong at the end might cause problems.

11.5 K6 – 2D CMM artefacts

Dr Viliesid had tabled the final report on the 2-D CMM artefact comparison [07-35] and now spoke to his presentation [07-35-1]. There were 12 participants and two artefacts: a ball plate and a bore plate. The laboratories sent the results in {x, y} coordinates and the analysis was made in polar {r, θ}. Most laboratories sent results rounded to the CMM resolution, which was generally not sufficiently accurate. The results had been analysed and had required removal of outliers. After taking weighted means, the graphs of the participants' results could be viewed. Some participants clearly had problems in their measurements. Fortunately, the artefacts were shown to be stable. 83% of the steel ball plate results and 75% of the zerodur bore plate results were shown to be consistent and these had contributed to the KCRVs for the artefacts.

Dr Balsamo asked why ball 1 was chosen as the reference point. The reason was that the protocol was based on a DKD guideline and nobody had suggested an alternative. It may be better to use a centroid of the data set, but this would have required much more re-working of the data on the comparison. However, the data did not show any problem on ball 1. Dr Stone commented that Dr Doiron (NIST) had extensive software to calculate all of the intra-ball distances for such comparisons and that he could make this available to pilots of future comparisons.

The pilot commented that the combination of the reversal method and the use of geometrically well-defined artefacts made the comparison able to test very special capabilities of CMM measurements. The chairman commented that it was not well aligned with measurement of difficult artefacts that would be a real key comparison test of client services. Dr Steele commented that the NRC based En toolkit could be useful for outlier determination and that Dr Decker had shown work on analysing this comparison's data using all intra-ball distances.

The meeting broke for coffee at 10:53 and resumed at 11:14.

The chairman asked for some more time for participants to approve the final report. **The chairman took an action to circulate the report to all WGDM members**. **All participants should examine the final report of comparison CCL-K6 and send comments to the pilot, Dr Viliesid, before 14 October 2007**. If there are no major comments, the report is **considered approved** and then Dr Viliesid should forward the report to the KCDB manager, informing the chairman.

Dr Wilkening commented that the EUROMET.L-K6 comparison was now starting **to be analysed by Dr Jusko.** The analysis may be slightly different from that given in CCL-K6.

Dr Takatsuji presented a report [07-35-2] on the APMP.L-K6 comparison. Participants were 9 APMP NMIs, 2 from SIM, and 3 from EUROMET. Circulation is delayed by 4 months and should conclude in 6 months time. Two artefacts are being circulated – a 620 mm ball plate and a special bore plate made by UNIMETRIK. This was a glass plate into which ceramic ring gauges had been glued. However the planarity of the rings was not ideal.

11.6 K7 – linescales

Dr Bosse presented the overview report [07-36] on linescale work. He reported that the EUROMET 100 mm scale comparison was running, and there was no desire to run any other comparisons at the moment. He reported on an informal comparison between Mitutoto, PTB and Heidenhain on an incremental encoder. The companies did not wish to publish the details of their uncertainties, but did give overall values. The work was to be published in *Precision Engineering*. The CCL strategic group should consider the issue of laboratories such as these who have uncertainties much better than CCL laboratories. Ms Tan mentioned that there had been a problem with the ATA Carnet for the linescale coming into Singapore.

Dr Bosse gave the report on behalf of Dr Acko (Slovenia) on the EUROMET 100 mm linescale comparison [07-36-1]. The schedule was OK so far. JV (Norway) had trouble with the size of the scale in their comparator, and they had thus modified their CMC. They had trouble mounting the 100 mm long scale on their comparator.

11.7 K8 – roughness

Dr Oliveira had given comments on the planned SIM roughness comparison on the previous day, during his SIM RMO report.

Ms Tan reported that there was a draft of the protocol for the APMP roughness comparison [07-37-2]. Dr Thomas remarked that if the CCL decided against promoting the roughness comparison to key comparison status, it would not be listed as xxxx.L-Kxx.

11.8 DG8 – thermal expansivity

Dr Matsumoto reported that he thought there had been no comments received on the previous version of the thermal expansion report, tabled again as [07-39] but Dr Thalmann mentioned that there had been some comments from METAS. Since then the report had been revised to draft B status [07-39-1]. **The chairman would send the Draft B report to the whole WGDM and comments were allowed for 4 weeks until 14 October.** If no major comments were received, the report would be considered as an approved final report.

PTB thought that there might be a need for an international comparison involute gear artefacts, but at o higher level than a supplementary comparison. **Dr Wilkening invited interested NMIs to contact him.** The chairman suggested this may be operated as a EUROMET comparison with non-EUROMET participants.

12. WGDM report to the CCL

The Chairman reviewed the Appendices to the 2007 minutes which included a summary of actions, decisions and recommendations.

13. Nanometrology

Dr Wilkening chaired a sub-meeting of the Nanometrology discussion group.

13.1 Particle measurement

The previous DG minutes had shown that nanoparticles was a key area in which the group needed to increase its knowledge. There was a workshop at NMIJ In February 2007, together with a laboratory visit. There was a feeling at the workshop that the APMP region was moving faster than the other regions, but several NMIs were now active in nanoparticles. In EURAMET there was a nanoparticle project proposal under the iMERA+ initiative. The workshop showed that the measurement of nanoparticles is not just a matter of dimensional properties, as chemical properties seemed more interesting. Dimensional measurement was being considered traceable through the use of NIST calibrated samples. Dr Matsumoto gave further details about the NMIJ workshop. There had been some attendees from EURAMET including PTB and NPL.

There would be a workshop on airborne nanoparticle measurement (as a EURAMET project) in Berlin in early October. This was not well known by the length community.

There is also an ISO TC on nanotechnology and WG2 on metrology. The most popular topics are the measurement of nanotubes. Dimensional particle measurement is not a key issue.

13.2 Nano pilot studies

Dr Wilkening reported on the situation on the remaining NANO pilot studies. NANO 5 is completed and the participants have received the first draft of the report. Dr Garnaes (pilot, DFM) is now progressing the second draft of the report.

EUROMET project 707 on step height measurements is completed and the follow-up comparison is under preparation. So far there are only EURAMET participants expected but others are invited. The follow-up comparison was needed for those labs with poor performance in project 707 or for those laboratories that had new equipment or services.

Regarding NANO1 (linewidth), Dr Stone reported that the Nanometrology group had been visited by PTB scientists earlier in the year. They had recommended that the proposed standard be replaced by a new one, produced by some German companies. It was hoped to complete the pre-circulation measurements within 6 months. Dr Bosse described the new standard [07-38-4]. The order of measurement was designed to put the most ‘damaging’ measuring systems at the end, e.g. optical then AFM then SEM techniques.

NANO6 had been proposed on measurement on a single crystal critical dimension reference material. This comparison would not start until after NANO1 was completed.

It had also been decided to carry out a nano research study on mono-crystalline steps on silicon.

The meeting broke for lunch at 13:11 and resumed at 14:18.

13.3 Length standards for nanometrology

It had been decided that WGDM should not propose work using quantum standards from other CCs where the length field already has intrinsic standards available.

WGDM was proposing free running He-Ne 633 nm lasers as low accuracy realisation of the metre, so it seemed the right time to nominate Nanometrology standards. Various standards reported at the last meeting were:

Bulk crystalline lattice

X-ray interferometry (up to 10 micrometers or up to 1 mm)

Incremental linescale (Atomic Moiré ruler)

It should be remembered that this is a material standard (i.e. not truly intrinsic, as properties depend on e.g. temperature). The standard has to be calibrated and the use is complicated.

Surface crystalline lattice

Useful for lattice and step height

Parameters to be taken have to be calibrated. For lateral standards the metals are to dislocation free nor pure enough: graphite – difficulties in preparation and SFM image interpretation; graphene – has too small a regular area; silicon – has oxide layer problems. For step heights, silicon may be useful if the terraces are big enough.

X-ray wavelength

Well defined x-rays in the Angstrom range. Alternatives are Mössbauer photons, but storage ring is needed before easily useable and the radiation source is difficult to utilise. Typical wavelength is 0.086 nm for ^{57}Fe. Unlike classical x-ray interferometry, the wavelength is not based on a lattice constant, but uses classical optical interferometry based on the photon wavelength.

Piezo effects in monocrystals

Linearity of elongation is not proven, even for pure crystals. Improved mono-crystals may overcome the linearity/noise problems of optical interferometers – this is needed for true atomic resolution for the x-y stage systems of AFMs.

Displacement effects in capacitors

Has to be calculated in practice. Difficult, and not an intrinsic scale standard.

Atomic linescales

Produced by atomic interference
Gain based on optical wavelengths with all their usual problems.

The most promising candidates for future standards seemed to be surface crystalline lattices and these may be more easy to use than the current x-ray wavelength standards.

The chairman welcomed the report from the DG moderator, and suggested that the DG could meet to have more detailed discussions at the NANOSCALE meeting, since the WGDM had decided [see §15] to meet there in 2008. It was suggested that the DG7 meeting should occur just after the NANOSCALE conference (possibly on the Tuesday afternoon) and then the WGDM could meet the day later.

13.4 NMIJ-PTB bilateral comparison report

This was reported on under agenda item 13.2.

13.5 APMP Nanometrology symposium

This had been described in agenda item 4.1.

14. Any other business

Ms Tan invited the meeting to consider participation at the SPRING Nanometrology Symposium which would start on 3 December 2007. Details were given in the updated information sheet [07-38-2].

15. Next meeting

There were three proposals for the location for the next WGDM meeting:

- Singapore, aligned with the Laser Metrology Symposium 30 June – 2 July 2008 [07-38-3].

- Rio de Janeiro, on 6 - 7 October (before the Congress taking place on the following days)
- Torino, Italy, 24 - 25 September, the days after the NANOSCALE meeting

It was noticed that there was a clash between the date of the Singapore meeting and the BIPM summer school 2008. This precluded this venue.

A vote was taken of the delegates for a preference of the 2 remaining venues.

- 3 delegates preferred Rio
- 9 delegates preferred Torino
- 7 delegates had no preference for the two
- the remainder of delegates did not vote

The preference was for the meeting on 24 – 25 September 2008 and this was accepted. **Dr Balsamo was asked to provide more details when they become available.**

The meeting closed at 13:00.

-- END WGDM 12 --

LIST OF ACRONYMS USED IN THESE MINUTES

(NMI acronyms are listed in the list of participants)

APMP	Asia Pacific Metrology Programme
BIPM	Bureau International des Poids et Mesures
CC	Consultative Committee
CCL	Consultative Committee for Length
CCL-K*n*	CCL Key Comparison number *n*
CMC	Calibration and Measurement Capability
COOMET	Coopération Métrologique (Euro-Asian RMO)
DG	WGDM Discussion Group
DimVIM	Document listing CMC categories for Length services, produced by CCL-WGDM
EC	European Commission
ER	Executive Report
EU	European Union
EURAMET	European Metrology Organization (European RMO), formerly EUROMET
JCRB	Joint Committee of Regional Metrology Bodies
KC	Key Comparison (CIPM)
KCDB	Key comparison and calibration database (of the BIPM)
KCRV	Key comparison reference value
MRA	Mutual Recognition Arrangement
NMI	National Metrology Institute
QMS	Quality Management Systems
RMO	Regional Metrology Organization (*e.g.* EUROMET)
SADC	Southern Africa Development Community
SADCMET	Southern Africa Development Community Cooperation in Measurement Traceability (RMO)
SC	Supplementary Comparison
SIM	Systema Interamericano de Metrologia (Inter-American RMO)
TC	Technical Committee
TC-L	Technical Committee for Length
WGDM	CCL Working Group on Dimensional Metrology
WGDM/01-nn	WGDM document, available from the server, or the Chairman
[07-xx]	Short form reference to WGDM/07-xx documents

LIST OF ITEMS DECIDED AT THE 12th WGDM MEETING

WGDM-2007.D1 Draft 4.2 of the 2006 WGDM minutes was accepted as final.

WGDM.2007.D2 WGDM agreed to accept the ongoing responsibility for the CMC review and coordination for the laser frequency/wavelength entries, as requested by the JWG.

WGDM.2007.D3 WGDM agreed to follow the suggestion of the BIPM Director to respond to the CIPM concerns via 2 documents: a simple response to the items listed in the 2006 CIPM minutes [07-06]; a paper (to be jointly authored with the BIPM) on the future of CCL key comparisons, based on a development of [07-01-1].

WGDM.2007.D4 The WGDM approved the final report on comparison CCL-K3.

WGDM.2007.D5 The WGDM approved the Executive report on comparison CCL-K4.

WGDM.2007.D6 The WGDM provisionally approved the final report on comparison CCL-K6, on the basis that no further significant changes were suggested before 14 October 2007.

WGDM.2007.D7 The WGDM provisionally approved the final report on the thermal expansion comparison, on the basis that no further significant changes were suggested before 14 October 2007.

LIST OF RECOMMENDATIONS MADE AT THE 12th WGDM MEETING

WGDM.2007.R1 WGDM recommended the promotion of the topic of surface texture to key comparison status. The list of agreed key comparison topics would therefore be: K11 (Mise en Pratique lasers), K1 (gauge blocks up to 500 mm), K3 (angle standards), K4 (cylindrical diameter standards), K5 (step gauge), K7 (line scales), K8 (surface texture). This list would be presented to CCL 2007 meeting.

WGDM.2007.R2 The WGDM recommended the setting up to of a small task force to discuss the linking of key comparisons. Membership would include Drs Giardini, Viliesid, Bosse and chairing would be Drs Brown / Decker.

WGDM.2007.R3 The WGDM recommended the setting up of a small task force to write, in collaboration with the BIPM, the paper on future CCL key comparisons. Membership would include Drs Lewis, Pekelsky, Giardini, Brown, Espina (and/or BIPM nominee) with Dr Thalmann chairing.

WGDM.2007.R4 The WGDM recommended the setting up of a task force on key comparisons. Members would include current DG moderators (Drs Thalmann, Lewis, Kruger, Stone, Jusko, Viliesid, Bosse). Moderators of new groups would also be members (Dr Doytchinov -To Be Confirmed, Dr Matus). The WGDM chairman would act as chairman, when necessary.

WGDM.2007.R5 The WGDM recommended the setting up of a task force on CMCs. Membership would include the RMO TC-L chairpersons, the Executive Secretary of the JCRB, the CCL Executive Secretary, the DimVIM coordinator and the KCDB Manager. The chairmanship of this task force would rotate and would start with Dr Oliveira (with help from Dr Pekelsky).

LIST OF ACTIONS FROM THE 12th WGDM MEETING

A.1 **All presenters** to forward copies of their reports (if not already sent) and any presentations made at the meeting, to **the Rapporteur**, for numbering and entry to the WGDM web site.

A.2 **Dr Lewis** to renumber and consistently re-title the documents before collecting together for the website, removing draft documents, and previous versions.

A.3 **The Rapporteur** to formally issue the approved minutes of the 2006 meeting, **via the Chairman**.

A.4 **Dr Vitushkin** to place the 2006 agreed minutes on the website.

A.5 **Any participant with** reliable contact details for length metrology staff at NIS, Egypt to forward those details to Ms Tan.

A.6 **TC-L chairs** to remind their members of the JCRB CMC access information as informed by Dr Espina.

A.7 **Dr Pekelsky** to discuss with Dr Thomas and Janet Miles the best way to present the multi-language DimVIM and to improve its visibility

A.8 **The chairman** to send a copy of the latest updated DimVIM to **Dr Lewis** to go onto the EUROMET website.

A.9 **Dr Pekelsky** to obtain the fs comb CMC information from the CCL-CCTF joint working group and create new entries in the DimVIM.

A.10 **Dr Lewis** to obtain the presentation and Excel file on linking from **Dr Steele** and send to **Dr Vitushkin** for placing on the website.

A.11 **Dr Lewis** to update the document on responses to the CIPM concerns, incorporating the changes suggested by Dr Espina then forward to **Dr Vitushkin** (copy Chairman) for it to be placed on the website.

A.12 **The Chairman** to inform **Dr Wallard** and the **CCL President** of the location of the document on responses to CIPM concerns [07-06], when it was available on the WGDM website, so that the CIPM could be aware of the responses.

A.13 **Dr Lewis** to examine the document [07-41] after the JCRB had produced its online summary of the MRA processes.

A.14 **Dr Kruger** to send the Excel file for the CCL-K3 results to the KCDB manager, for placing on the KCDB.

A.15 **Dr Kruger** to prepare the Executive Report on the CCL-K3 comparison and send to the Chairman for distribution.

A.16 **Dr Lewis** to remind the **pilots of EUROMET.L-K4.2006** that the Draft A report does not need to include analysis – it can just be a table of results.

A.17 **The chairman** to circulate the final report of **CCL-K6** to all WGDM, including the CCL Executive Secretary.

A.18 **All WGDM members** to examine the final report of comparison **CCL-K6** and send comments to the pilot, **Dr Viliesid**, before 14 October 2007. The chairman would then circulate any amended report.

A.19 **The chairman** to circulate the final report of **the thermal expansion comparison** to all WGDM, including the CCL Executive Secretary.

A.20 **All WGDM members** to examine the final report of the thermal expansion comparison and send comments to the pilot, **Dr Matsumoto**, before 14 October 2007.

A.21 **Any participant** to contact Dr Wilkening if they are interested in a comparison on involute gear artifacts.

A.22 **Dr Balsamo** to inform the WGDM of the details for the next meeting, when they becomes available.

A.23 **The chairman** to prepare a schedule of the length key comparisons before the next WGDM meeting. This schedule to include details of the phasing between the regions.

A.24 **The chairman** to identify those documents created by the WGDM that could be put on the open access part of the WGDM website.

A.25 **All participants** to send corrections and edits on the 2007 minutes to **the Rapporteur**.

– fin –