Bureau International des Poids et Mesures

Consultative Committee for Length (CCL)

Report of the 13th meeting
(13 – 14 September 2007)
to the International Committee for Weights and Measures

Comité international des poids et mesures

Note:

Following a decision made by the International Committee for Weights and Measures at its 92nd meeting in October 2003, reports of meetings of Consultative Committees will henceforth be published only on the BIPM website in the form presented here.

Full bilingual printed versions in French and English will no longer appear.

A.J. Wallard,
Director BIPM,
September 2005

LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR LENGTH

AS OF 13 SEPTEMBER 2007

President

Dr Myung Sai Chung, Member of the International Committee for Weights and Measures, University of Science and Technology, Daejeon.

Executive Secretary

Mr Raymond Felder, International Bureau of Weights and Measures [BIPM], Sèvres.

Members

Centre for Metrology and Accreditation/Mittatekniikan Keskus [MIKES], Espoo.

Centro Nacional de Metrología [CENAM], Querétaro.

Conservatoire National des Arts et Métiers/Institut National de Métrologie [LNE-INM], La Plaine-Saint-Denis.

Czech Metrology Institute/Český Metrologický Institut [CMI], Prague.

D.I. Mendeleyev Institute for Metrology, Rostekhregulirovaniye of Russia [VNIIM], St Petersburg.

Federal Office of Metrology/Office Fédéral de Métrologie [METAS], Bern-Wabern.

Istituto Nazionale di Ricerca Metrologica [INRIM], Turin.

Korea Research Institute of Standards and Science [KRISS], Daejeon.

National Institute of Metrology [NIM], Beijing.

National Institute of Standards and Technology [NIST], Gaithersburg/Joint Institute for Laboratory Astrophysics [JILA], Boulder.

National Measurement Institute, Australia [NMIA], Lindfield.

National Metrology Institute of Japan, Advanced Institute of Science and Technology [NMIJ/AIST], Tsukuba.

National Metrology Institute of South Africa, [NMISA], Pretoria.

National Metrology Institute of Turkey/Ulusal Metroloji Enstitüsü [UME], Gebze-Kocaeli.

National Physical Laboratory [NPL], Teddington.

National Research Council of Canada, Institute for Measurement Standards [NRC-INMS], Ottawa.

NMi Van Swinden Laboratorium/Nederlands Meetinstituut [NMi VSL][*], Delft.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

Slovak Institute of Metrology/Slovenský Metrologický Ústav [SMU], Bratislava.

The Director of the International Bureau of Weights and Measures [BIPM], Sèvres.

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* Renamed “VSL”.

Observers

Centro Español de Metrología [CEM], Madrid.
Standards, Productivity and Innovation Board [SPRING], Singapore*.

* Renamed "Agency for Science, Technology and Research [A*STAR], Singapore".

1 OPENING OF THE MEETING; APPOINTMENT OF RAPPORTEURS; APPROVAL OF THE AGENDA

The Consultative Committee for Length (CCL)* held its 13th meeting at the International Bureau of Weights and Measures (BIPM) headquarters, Sèvres, on Thursday 13, and Friday 14 September 2007. Three sessions were held.

The following delegates were present: P. Balling (CMI), R.H. Bergmans (NMi VSL**), J.C. Bergquist (NIST), F. Bertinetto (INRIM), N. Brown (NMIA), M.S. Chung (President of the CCL), R. Fira (SMU), GAO Sitian (NIM), W. Giardini (NMIA), P. Gill (NPL), F.-L. Hong (NMIJ/AIST), P. Juncar (LNE-INM), J.-W. Kim (KRISS), P. Kren (CMI), O. Kruger (NMISA), A. Lassila (MIKES), P. Lemonde (LNE-SYRTE), A. Lewis (NPL), A. Madej (NRC-INMS), H. Matsumoto (NMIJ/AIST), L. Mostert (NMISA), J. Pekelsky (NRC-INMS), F. Riehle (PTB), A.G. Steele (NRC-INMS), J. Stone (NIST), T. Takatsuji (NMIJ/AIST), R. Thalmann (METAS), G.-P. Vailleau (LNE), M. Viliesid (CENAM), A.J. Wallard (Director of the BIPM), G. Wilkening (PTB) and T. Yandayan (UME).

Observers: E. Prieto (CEM), S.L. Tan (SPRING***).

Guests: M. Matus (BEV), J.C. Oliveira (INMETRO).

Also present: R. Felder (Executive Secretary of the CCL), J.R. Miles (BIPM), L. Robertsson (BIPM), C. Thomas (Coordinator of the KCDB), L.F. Vitushkin (BIPM).

Apologies: A. Balsamo (INRIM), K. Chekirda (VNIIM).

Dr Chung welcomed the participants to the 13th meeting of the Consultative Committee for Length (CCL) and Prof. Wallard added his welcome on behalf of the BIPM. Mr Felder mentioned a few items of local housekeeping. A little later in the agenda, the meeting participants were asked to introduce themselves as there were some persons who were new to the CCL.

The President thanked Dr Lewis for his work as Rapporteur for the 12th meeting and invited him to act as Rapporteur for the 13th meeting. The meeting agreed.

The order of some agenda items was changed, and the revised order is used in this report.

2 REPORT ON ACTIONS ARISING FROM THE SEPTEMBER 2005 MEETING

Mr Felder reported that there had been some changes within the BIPM since the last CCL meeting. The Length Section had been reduced in size and eventually closed, with remaining

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* For the list of acronyms, click here.

** Renamed "VSL".

*** Renamed "A*STAR".

staff merging with those of another Section. In July 2006 Dr Arias took over as head of the Time, Frequency and Gravimetry (TFG) Section. The actions of the TFG Section in 2007 included construction of iodine cells, maintenance of BIPM lasers at 633 nm and 532 nm, maintenance of the BIPM absolute gravimeter, maintenance of high vacuum systems for cell filling, and a comparison of gravimeters.

Prof. Wallard mentioned other actions arising from the minutes of the previous meeting. The action on CMCs would be reported on later. A group had been set up to discuss unstabilized lasers and the Chairman of the group would report later in the agenda. Prof. Wallard had started dialogue with the CCTF on the possibility of a joint workshop with CCL but it had been felt that the time was not yet ready for this. There had been one or two other actions for the Working Groups, but these would be reported on in the relevant agenda points.

3 LINKS BETWEEN THE CIPM MRA AND THE CONSULTATIVE COMMITTEES – REPORT BY THE DIRECTOR OF THE BIPM

Prof. Wallard made some remarks that he felt would be useful to bear in mind for the discussions later in the agenda. There were now 51 Member States of the BIPM and the recent addition of Albania had increased the number of Associates States to 23. He expected another 2 or 3 NMIs to become signatories to the CIPM MRA during the forthcoming meetings of the CGPM and NMI Directors. He referred to recent activities designed to help newer Member States and encourage them to take part in the MRA, in particular in the preparation of CMCs for entry into the KCDB. A proposal would be put to the 23rd meeting of the CGPM to create the category of Corresponding NMI of the BIPM as a first step to becoming Associate States of the CGPM or Member States of the BIPM. The majority of Consultative Committees had followed the example of the CCQM which had set up a specific Working Group on CMCs. He encouraged the CCL to consider this during discussion under a later agenda item and to decide how the CCL wished to address the regional and inter-regional review of CMCs. The BIPM itself was also moving towards a clear and more detailed presentation of its own uncertainties and this was important as some NMIs were attributing excessively small uncertainties to some of their national standards, based on their traceability claims to services and standards held at the BIPM.

4 REPORT FROM THE WORKING GROUP IN DIMENSIONAL METROLOGY

The Chairman of the CCL Working Group on Dimensional Metrology (WGDM), Dr Thalmann, presented the report on the work of the group since the last meeting of the CCL in 2005. Dr Thalmann thanked the previous WGDM Chairman, Dr Brown, for his work and mentioned that the 2007 WGDM meeting was the first for Dr Thalmann as the group's Chairman. There had been two WGDM meetings in the last two years – a meeting in Querétaro in October 2006 and another at the BIPM in September 2007. The meetings had discussed: RMO reports, CIPM

MRA activities (CMCs, DimVIM), WGDM business (including Terms of Reference), key comparison reports, the discussion group DG7 on nanometrology, statistical evaluation of results, linking of key comparisons and addressing the concerns of the CIPM.

He reported that for some time the WGDM had been operating several discussion groups:

DG2	Gauge blocks	(R. Thalmann, METAS)
DG3	Length bars	(A. Lewis, NPL)
DG4	Angle	(O. Kruger, NMISA)
DG5	Diameter	(J. Stone, NIST)
DG6	CMM	(O. Jusko, PTB)
DG7	Nanometrology	(G. Wilkening, PTB)
DG8	Thermal expansion	(H. Matsumoto, NMIJ)
DG9	Line scales	(H. Bosse, PTB)

All these discussion groups deal with the technical topics of the key comparisons, except DG7 and DG8 which discussed technical issues and had operated pilot studies. The groups acted when needed, and the WGDM performed the overall coordination of the key comparisons.

DG7 on nanometrology had met four times in the last two years: April 2006 at METAS, October 2006 at CENAM, February 2007 at NMIJ, and September 2007 at the BIPM. They had operated a successful series of NANO pilot studies and a bilateral comparison, the status of which were:

Nano1	Linewidth (CD mask)	Starting
Nano2	Step heights	Completed
Nano3	Line scales	Completed
Nano4	1D gratings	Completed
Nano5	2D gratings	Draft A
Nano6	Linewidth (Single crystal CD)	Delayed
NMIJ-PTB	1D gratings (pitch < 100 nm)	Completed

DG7 has discussed possible future length standards for use in nanometrology. These include bulk crystalline lattices, surface crystalline lattices, x-ray wavelengths, piezo effect in mono-crystals, displacement depending capacitors, and atomic linescales.

The WGDM reported significant progress in the length key comparisons over the last two years:

CCL-K3	Angle	Final report for approval
CCL-K4	Diameter standards	Results in the KCDB
CCL-K5	Step gauge	Results in the KCDB
CCL-K6	Ball plate	Draft B available
CCL-Sxx	Thermal expansion	Draft B available
APMP.L-K4	Diameter standards	Draft A due soon
APMP.L-K5.2006	Step gauge	Measurements almost completed
APMP.L-K8	Surface roughness	Technical protocol available

EUROMET.L-K2	Long gauge blocks	Results in the KCDB
EUROMET.L-K4.2005	Diameter standards	Draft A due soon
EUROMET.L-K5.2004	Step gauge	Measurements almost completed
EUROMET.L-K6	Ball plate	Draft B expected
EUROMET.L-K7.2006	Line scales	In progress

Regarding CMCs, the main review work is performed by the RMOs as usual and the task within WGDM is that of international coordination. No major problems had been encountered. The WGDM is particularly active in the monitoring of CMCs when key comparison reports are available. For each comparison, it performs this work through the use of Executive Reports which detail corrective actions. A guidance document by Dr Lewis is available (WGDM/07-41 "*Running of MRA comparisons in length metrology and monitoring their impact on CMCs*") and some requests have been received for this document to be made available to a wider audience, outside the CCL-WGDM.

The CMC categorization list, known as the DimVIM, is now available in 12 languages (Chinese, Czech, English, Finnish, French, German, Italian, Japanese, Korean, Portuguese, Spanish and Turkish) and can be accessed via the BIPM and KCDB websites, which provide links to http://www.euramet.org/. The scheme has been used externally to the CIPM MRA as a list of services used by accreditors, and other organizations.

Regarding the key comparison portfolio, the CCL in 2003 had approved certain changes to the list of key comparison topics that would be maintained after the end of the first round of key comparisons was completed. Comparisons CCL-K2 on long gauge blocks (up to 1 m) and CCL-K6 on 2-dimensional CMM artefacts had been removed from the list and CCL-K8 on surface roughness standards had been added. Since then the laser comparison BIPM.L-K11 was being concluded and a new laser comparison CCL-K11 was to be started to serve the needs of the dimensional metrology community, though it would, as a result of discussions and decisions in the WGDM and the CCL/CCTF Joint Working Group, be organized by the CCL-CCTF Joint Working Group on Frequency Standards (JWGFS). Recent discussion within the WGDM had resulted in the request to change the title of CCL-K8 from 'surface roughness standards' to 'surface texture standards' as this allowed a wide range of artefacts to be measured.

The full list of CCL key comparisons therefore becomes:

CCL-K1	Gauge blocks up to 500 mm (including former CCL-K2)
CCL-K3	Angle standards (polygons and angle blocks)
CCL-K4	Cylindrical diameter standards
CCL-K5	Step gauge
CCL-K7	Line scales
CCL-K8	Surface texture standards
CCL-K11	MeP stabilized lasers (former BIPM.L-K11)

The CCL approved the renaming of the CCL-K8 comparison.

Regarding the relationship with the JWGFS, WGDM supports that the JWGFS take the responsibility for CCL-K11. The WGDM accepts the responsibility for coordinating the CMC review for comb-based frequency calibrations and will request advice from the JWGFS for the

new service categories to be added in the DimVIM. The WGDM anticipates guidance from JWGFS on how combs are to be validated for CCL-K11 nodes and for laboratories having their own comb and thus not necessarily participating in CCL-K11. The WGDM has taken note of the request from the JWGFS to review their proposed frequency list in the light of its potential use for dimensional metrology, but it has not yet seen the list.

At its meeting in 2006, the CIPM had expressed some concerns and had requested certain actions related to the CCL and the WGDM. These concerns and issues, which had been discussed at the 2006 WGDM meeting, included:

- Why gauge block comparisons warrant a different approach from other artefact-based comparisons.
- Inclusion of the linking of comparisons as part of the protocol.
- Addressing the question of stability by adopting a star formation for the comparisons.
- A recommendation that the WGDM meet at the BIPM regularly.
- The need to develop a self-standing document from the CCL on how future comparisons would be organized.
- The need to develop a paper on the limitations of gauge block comparisons and the consequences for linkages.

After some analysis, the WGDM agreed the two essential points of these concerns: problems with the CCL-RMO comparison scheme; and questions related to the linking of CCL and RMO comparisons.

The WGDM recognizes the importance of the concerns and was taking action to address them. It was responding directly to the questions through a document WGDM/07-06 "*WGDM comments on minutes of 2006 CIPM meeting*", prepared at the 2007 WGDM meeting and soon to be placed on the WGDM website. The document would also be forwarded to the CCL President and BIPM director who will ensure that the CIPM is aware of this document and the responses of the WGDM and the CCL.

Additionally, document WGDM/07-01 "*CCL comparison scheme*" was being prepared and this would form the basis for a paper for which the BIPM and the JCRB secretary have offered co-authorship. This would describe the proposed comparison scheme, which had the flexibility that the WGDM sought, satisfied the needs of the CIPM MRA, and took into account problems encountered in CCL key comparisons and showed solutions on how adequately to link the comparisons. The document would be ready before the 2008 meeting of the CIPM so that the CCL President and/or the BIPM Director could make it available to the CIPM meeting.

In terms of the CCL Working Group structure, WGDM was made aware of the NRC proposal for reorganization and had discussed it in the 2007 meeting. WGDM found consensus that the proposed changes need further consideration. WGDM proposes a provisional structure which would be presented under a later agenda item.

With that, Dr Thalmann concluded his report and mentioned that the report would be made available on the restricted-access CCL and WGDM document servers:

(http://www.bipm.org/en/committees/cc/ccl/).

Prof. Wallard asked how Dr Thalmann saw the DG7 nanometrology group developing: would it remain focused only on dimensional metrology or would it develop to cover cross-CC subject areas? Dr Thalmann's opinion was that this was a difficult question as the NMIs active in this subject found it difficult to obtain details of the real needs of industry. In many cases, industry did not wish for traceability, and so the NMIs were working only on specific areas that had seen requests for traceability. The CCL was concerned only with issues where traceability to the SI was required. He asked Dr Wilkening, the DG7 moderator, to give further comments.

Dr Wilkening agreed with Dr Thalmann. Many of the measurements in nanometrology were chemical in nature, and dimensional traceability was not yet a key concern. If the CIPM wanted to put more effort into nanometrology as a whole, it should do this across the CCL as well as some other Consultative Committees. For example, in the area of nanoparticles, the toxicity concerns were often based on chemical properties, not on dimensional properties.

Dr Steele mentioned the work of the ISO committees on nanometrology, where toxicity concerns were one of the main focuses. He felt that the work in nanometrology would need coordination across Consultative Committees and expected eventually to see a cross-CC Working Group on nanometrology. One of the main industries where nanometrology was key was in the measurement of critical dimensions for the semiconductor industry and he welcomed the existing work of DG7 which had anticipated these concerns in the way that the Nano pilot studies had been organized and operated. Dr Thalmann responded that there should be caution when considering the semiconductor industry; major companies had expressed the view that the companies could set up the necessary traceability themselves and in many cases the costs associated with this were so high that only large companies could fund this level of activity on short timescales – it far exceeded the resources available in the NMIs. He suggested that the smaller companies had the greater need for traceability in nanometrology. Dr Steele agreed but cited the forward-looking programmes in NMIA and NIST that were trying to tackle these problems.

Prof. Wallard mentioned the previous situation in the early semiconductor industry where each company had its own standards. It was only when interoperability was required, that traceability issues became key. Dr Steele also cited an example from a small lithography company that had taken the step to replace in-house standards with NIST references, making a significant investment. Dr Wilkening gave an example of a major mask stepper manufacturer in Germany, which was more concerned with repeatability, over several years, rather than traceability. This was provided by using calibrations made at PTB.

Dr Matsumoto mentioned that CCL members had developed many technologies and the challenge was to see how they can apply these to the field of nanotechnology. Dr Kim agreed; in Korea the industries associated with nanotechnology are making use of very new technologies.

Dr Giardini reported that the Australian Government has set up a programme on nanometrology, with the NMIA performing an underpinning role for metrology. However he reminded the meeting that the NMIs had to serve the real needs of industry and the NMIs had limited resources. They had to focus their efforts on traceability routes that were really needed by industry rather than trying to tackle everything. Dr Stone agreed and mentioned the problems where million dollar machines had been purchased as being state-of-the-art, only to be superseded by billion dollar machines shortly afterwards – the costs associated with maintaining position in leading edge nanometrology were significant. Dr Thalmann mentioned that it was not

only nanometrology that was important; in many cases the critical aspects were more in the field of micro-metrology.

Dr Lewis mentioned his experience at an international workshop in Europe where device manufacturers and industrial users had concluded that a manufacturing chain which is entirely in-house is useful in maintaining competitive advantage by protecting intellectual property, and only when interoperability was necessary, was consideration given to external traceability. This interoperability was mostly concerned with packaging and the metrology needs here were at the micrometer scale, not nanometrology.

Dr Chung thanked the meeting for the interesting discussions and said that he and Prof. Wallard would report on this work to the CIPM.

5 REPORT OF THE CCL/CCTF FREQUENCY STANDARDS WORKING GROUP

Dr Gill described the work of the JWGFS which had met earlier in the week. The meeting had discussed the organizational changes which had resulted from the decision to form a single WG responsible for the frequency standards list. A key discussion point had been the need to report to both CCL and CCTF. He was concerned about any potential for delay that this dual reporting route could cause when updating frequency values in the published list(s).

The organization of the comparison CCL-K11 and its Terms of Reference had been discussed and this had led to discussions on the validation of combs. Some consideration had been given to updating the current list of frequency standards and there had been some discussion on the future arrangements for publication in *Metrologia*.

At the 2005 CCL and 2006 CCTF meetings the creation of the single group had been discussed and approved. The original two groups coming from the two CCs had ceased to exist and the single group was now responsible for the frequency list. In 2006 the CIPM had approved several secondary representations of the second.

The JWGFS is a combined WG charged with maintaining the single list of high accuracy frequencies or vacuum wavelengths. It caters for the needs of different communities, including:

- Secondary representations of the second, with a view to a future redefinition of the second;
- Requirements of the dimensional metrology community in respect of stabilized lasers for the realization of the metre;
- Standards within the infrared telecommunications region;
- Accurate frequencies for fundamental constants and basic physics.

It was clear that the frequency list is no longer intended solely for the realization of the metre, but it was important that the unified list of frequency standards continue to be considered the common reference point for frequency/vacuum wavelength values for the metrology community as a whole. It was necessary for the JWGFS to ensure a single value and uncertainty for each radiation in the list. The proposed solution to the dual reporting requirements was to synchronize the CCL and CCTF meetings and hold a single JWGFS meeting immediately before the two CC

meetings. This would reduce travel costs and result in faster approval of the changes to the frequency list by both CCs.

The first two points of the Terms of Reference of the JWGFS had been agreed by the CCTF and CIPM in 2006, namely:

1. To make recommendations to the CCL for radiations to be used for the realization of the definition of the metre and to make recommendations to the CCTF for radiations to be used as secondary representations of the second;
2. To maintain together with the BIPM the list of recommended frequency standard values and wavelength values for applications including the practical realization of the definition of the metre and secondary representations of the second;

Additional Terms of Reference were now proposed to the CCL for approval:

3. To take responsibility for key comparisons of standard frequencies such as CCL-K11;
4. To respond to future needs of both the CCL and CCTF concerning standard frequencies relevant to the respective communities.

These were proposed to the CCL as a recommendation for inclusion in Section 15.

There had been discussion on the CCL-K11 key comparison. The BIPM was no longer able to take charge of this comparison as a result of the recent decisions of the CIPM and especially the closure of the Length Section. Instead, the comparison would be operated by the NMIs (1 pilot, 5 regional nodes, plus hosts if appropriate). The protocol had been drafted and would be refined and this task was assigned to Dr Robertsson and the node/pilot laboratories. The node/host laboratories provide comb measurements on stabilized lasers with the comparison targeted on the requirements of the dimensional community. The JWGFS had concluded that it should be emphasized that this was a comparison and not a calibration service. It had been generally felt to be the means to assess an NMI's capability to realize the SI metre at the level of parts in 10^{11} or parts in 10^{12}, either by comb measurement (method "b") or by stabilized laser operation according to MeP recipe (method "c"). It was noted that the comparison could measure/compare values for any stabilized laser operating near MeP values or at totally different vacuum wavelengths by means of comb measurement.

The necessary validation of the combs was not aimed at demonstrating comb measurements at uncertainty levels relevant to high accuracy frequency standards, but only at an accuracy level sufficient for the metre realization. Several possible methodologies had been discussed and these had been classified into three categories depending on their perceived applicability and validity:

Good validity

- directly compare 2 comb measurements at the same laboratory on the same high stability laser (only relevant to nodes with 2 or more combs),
- compare measurements of a transfer standard based on a stabilized laser at separate laboratories (1 node laboratory + 1 host laboratory),
- measure (and compare with other published data) a known stable frequency such as an optical clock transition (nodes/hosts with cold atom standards).

Medium validity

- measure a number of known MeP lasers and compare with known values, other similar measurements elsewhere,
- fully analyse comb internal control functionality (e.g. beat S/N, PLL performance).

Poor validity

- make uncertainty evaluation of capability (valid under ISO?),
- assume comb manufacturer has validated system.

Results from the questionnaire on new frequencies had been tabulated by Mr Felder, and these were shown. There were relatively few requests from the NMI community to have updates to existing values, though several new values had been submitted.

Dr Gill returned to the frequencies recommended by the CIPM in 2006, to inform the CCL that these changes had been made to the list.

Two new values were discussed, but the JWGFS wished to wait until the next CCTF before proposing formal changes to the list.

Dr Riehle continued the presentation from the CCTF point of view. There had been an invited talk and associated publication on the JWGFS at the EFTF 2006. The JWGFS had met in September 2006 prior to the CCTF meeting, and there had also been a meeting immediately prior to the CCL meeting in 2007.

A first draft of the single frequency list had been prepared and was 40 pages long already. Due to the large number of modifications and the new function of the list, it was felt that the complete list should be published in *Metrologia*. The form of this list follows in general the outline of the last complete list (T.J. Quinn, *Metrologia*, 2003, **40**(2), 103-133), based on the results from the 2001 CCL meeting. Modifications had been made in order to reflect the structure of the list of frequencies on the BIPM website. Authors are from the JWGFS (F. Riehle and P. Gill) and the Executive Secretaries of the CCs (F. Arias and R. Felder, BIPM).

The list is split into two parts: the ‘living list’ and the ‘frozen list’. The first part includes radiations of high accuracy that are of utility for the realization of optical frequencies and vacuum wavelengths. For up-to-date values and their uncertainties please refer to the BIPM website. The second part of the list includes radiations that are still deemed of utility for various applications but may have larger uncertainties and which will in general have no future updates of their values. The list has three appendices:

- Appendix 1 – Secondary representations of the second
- Appendix 2 – Commonly used frequency standards for the realization of the definition of the metre
- Appendix 3 – Source data and frequency differences.

Dr Riehle showed some examples and excerpts from the list. The first draft had not yet been communicated to the WGDM but there had been a discussion with the editor of *Metrologia*. The next steps were to have a meeting some time in 2008, possibly in conjunction with the CPEM, and then meet again immediately before the next meeting of the CCTF which might be in spring 2009.

Dr Stone asked about the language of the list and whether or not it precluded inclusion of unstabilized lasers. Dr Riehle responded that the JWGFS had wished to wait for Dr Stone's report before making a decision and that Prof. Wallard would be consulted on the exact wording.

Dr Brown asked about the Terms of Reference for key comparison CCL-K11. He had noted that the JWGFS had reported that non-MeP lasers were now included in the list of lasers that could be measured during this comparison. However, the original intention was that CCL-K11 was for MeP lasers being used as national length standards. Dr Brown asked if it was necessary for an NMI making traceability to the second using its own laser calibrated by femtosecond comb measurement to take part in the CCL-K11 comparison. It seemed that only MeP lasers had to take part in CCL-K11. Dr Riehle commented that the ability to measure other lasers had been added to the CCL-K11 comparison in order to cope with the fact that non MeP lasers might need to be validated to ensure that their performance was as expected. Dr Gill responded that taking part in CCL-K11 was not obligatory but it gave confidence.

Dr Giardini asked if there was a difference between a key comparison being used to derive degrees of equivalence of national standards or being used to validate the performance of laser standards. Dr Gill responded that comparisons like CCL-K11 could be used for both. Dr Brown was concerned that national standard lasers that took part in CCL-K11 would then become secondary standards since they became calibrated items traceable to the second. Dr Thalmann emphasized that the traceability to the SI was critical, and that national standards were just the best realizations that are available. Primary standards such as stabilized lasers may actually be traceable to the SI via the second, but they still need to be compared. CCL-K11 is such a comparison.

Dr Steele described the use of water triple point cells to address the situation in thermometry which he thought was analogous. He was concerned that the importance of the *Mise en pratique* was being lost. Would there be sufficient authority to the list of frequencies to ensure the special situation of lasers that can be built, operated and considered as high-level, practical realizations of the metre? Dr Madej assured Dr Steele that the detailed text and the necessary guidance of the former *Mise en pratique* document had not been lost and this would still be captured in any future document. Dr Stone welcomed the frequency list and asked how it dealt with the validation of combs – did he have to compare his comb with another? Dr Gill responded that the new document was not designed to describe comb validation techniques but there was a prototype document in preparation on this subject. He did not feel that comb comparisons were necessary to validate these nodes at this level of uncertainty. Prof. Wallard mentioned that he thought comparisons of standards were still necessary. He asked if the new document was the new *Mise en pratique*, or was it only Appendix 2 which now fulfilled this role? Dr Gill responded that the JWGFS had carefully avoided using the term *Mise en pratique*. Dr Thomas mentioned that the SI Brochure published in 2006 would now need updating, or at least the Appendix 2 that was now published electronically on the BIPM website. Further thought was necessary to work out the link between the MeP, the new list and the SI Brochure text.

Prof. Wallard asked if the 3rd and 4th audiences identified as users of these frequency standards had associated with them relevant CCs to which the JWGFS could report, for example the frequencies appropriate to optical communications. Dr Riehle responded that the JWGFS had left the reporting route open for these, whereas in the past it had reported to CCL.

Dr Giardini queried the use in some comments of the term ‘primary standard’ since the VIM did not allow a primary standard to be based on reference to another standard and the calibration of a primary laser therefore made it secondary.

Dr Thalmann asked for clarification regarding the three frequency lines given so far in the list that were appropriate for the length community. It was not clear what consequences there would be and this needed consideration. Dr Steele asked if this was a discussion that should be taken on by a task force of the CCL. Prof. Wallard responded that the lines were of importance to dimensional metrology so it was the remit of the WGDM to respond. The wavelengths had been chosen as being of particular relevance to the dimensional community. Dr Thalmann added that the acetylene-stabilized 1.5 μm radiation might also be considered as it was commonly used. Dr Pekelsky added that he considered that Appendix 2 should also contain the values from the spectral lamps. Dr Riehle and Dr Brown confirmed that no values had been removed from the overall list. However the lamp radiations were now consigned to the ‘frozen’ list, even though they were still in use, and not only by the length community. The forthcoming discussion on the unstabilized lasers would also be seeking a suitable location to publish the values. Could these and also the standards being investigated within DG7 on nanometrology be included in Appendix 2? Dr Riehle considered that the list could not contain such items as crystal lattice parameters.

Dr Thalmann suggested that it might be better to have a separate CCL document which would contain both the values from Appendix 2 and the new standards for nanometrology. Dr Riehle agreed, provided that the CCL document would clearly make reference to the frequency list. Dr Madej and Prof. Wallard preferred to keep the JWGFS list for only the highest quality values but welcomed the use of a second CCL document. Dr Steele asked if NMIs were still using spectral lamps. Drs Stone and Bergquist mentioned that NIST still used traceability to spectral lamps and there was no pressure to withdraw them from the frequency list. The consensus of the meeting was that there was a desire from frequency standards experts to keep in the frequency list only high-level standards, but there was a need for a separate list for use in dimensional metrology.

It was agreed that the WGDM take the action to prepare the separate document which would include radiations and other standards that are important in dimensional metrology.

6 RELATIONSHIP BETWEEN CCL AND CCTF AND SYNCHRONIZATION OF FUTURE MEETINGS

Prof. Wallard reiterated the difficulties of the joint reporting structure for the JWGFS. The proposed solution was to synchronize future meetings of the CCL and CCTF and moves were under way to set this up.

The next meeting date for both Consultative Committees was suggested as June-July 2009 and the CIPM would need to approve this. The CCTF had already agreed to move its meeting to 2009.

7 NEW ORGANIZATION OF THE CCL AND ITS WORKING GROUPS

Dr Steele spoke about a document that he had tabled at the WGDM meeting. This had proposed setting up several new Working Groups of the CCL, and closure of the WGDM. He had revised the proposal following the discussions at the WGDM and he presented the revised document. Since the previous draft, the proposed number of Working Groups had been reduced and these were now:

WG1	JWGFS CCL-CCTF
WG2	WGDM
WG3	Strategic planning
WG4	Key comparisons
WG5	CMCs
WG6	Nanometrology

Dr Thalmann showed some slides describing an alternative structure and reasons behind it. WGDM is aware of the usual structure of CIPM CCs and that new and demanding tasks are to be faced and that imminent problems have to be addressed such as the CCL comparison structure and the linking of CCL comparisons. WGDM recalls that it has been able to accomplish successfully all tasks within the present structure. It was the first CC Working Group to define a coherent set of service categories and the first CC Working Group to approve CMCs for publication on the KCDB. It also efficiently runs and completes a large number of key comparisons. With the move of the CCL-WGMeP into the joint CCL-CCTF JWGFS, the membership, tasks and agenda of the CCL need to be reconsidered. Thus important changes for CCL are expected.

The meeting of the WGDM had found consensus on several points:

- the proposed changes need further consideration;
- the coordination of a large number of Working Groups would place additional burdens directly on the CCL;
- a definitive change of the Working Group structure within CCL should be postponed;
- the WGDM shall remain at the moment with its present Terms of Reference and with an ability to assign specific responsibilities to provisional task forces;
- the WGDM will operate − until further notice − according to a scheme outlined in the following:

  A task force on the linking of key comparisons. Co-chairs: Dr Brown and Dr Decker. Additional members: Dr Bosse, Dr Giardini, Dr Viliesid.

  Task force on the CCL key comparison scheme paper. Chair: Dr Thalmann, Co-authored by BIPM. Additional members: Dr Giardini, Dr Lewis, Dr Pekelsky.

- WGDM discussion groups would remain the same:

DG2/3	Gauge blocks	(A. Lewis, NPL/R. Thalmann, METAS)
DG4	Angle	(O. Kruger, NMISA)
DG5	Diameter	(J. Stone, NIST)

DG6	CMM	(O. Jusko, PTB)
DG7	Nanometrology	(G. Wilkening, PTB)
DG8	Thermal expansion	(H. Matsumoto, NMIJ)
DG9	Line scales	(H. Bosse, PTB)
DGx	Surface texture	(K. Doytchinov, NRC, to be confirmed)

- In addition virtual task forces would be formed:

  Task force on key comparisons.
  Chair: WGDM Chairman. Members: Moderators of DGs 3, 4, 5, 6, 9, x.

  Task force on CMCs.
  Chair: Dr Oliveira (supported by Dr Pekelsky). Members: RMO TC-L chairpersons. Additional members: JCRB Executive Secretary, CCL Executive Secretary and KCDB Manager.

Dr Brown was of the opinion that the apparent need to change the structure was not because the work was not being done, but because the work of the CCL Working Groups was not well presented outside of the CCL. He was concerned that changing a structure which worked well could cause problems.

The WGDM Chairman responded that this was why he had suggested keeping most of the current structure, but making the many tasks of the group clearer to the outside world. This also had the advantage that it did not cause additional work for the CCL, to keep track of and organize more Working Groups at the higher level.

Dr Steele responded that the tasks that were allocated to the task forces were normally performed by CC Working Groups. He agreed that the main problem was one of visibility and suggested the solution to this was to reform the CCL according to structures used in other CCs. These Working Groups could come together during a plenary session of the CCL. He did not wish to see the Terms of Reference of the WGDM expand so far that it became those of a Consultative Committee.

Dr Pekelsky agreed and added that he thought that the new structure would probably have to exist at some time and he thought that the CCL needed to change to match the requirements set out by the CIPM. He mentioned that this may see the CCL meeting extend to three days because it would require more time for the Working Groups to have their individual meetings, but he welcomed this if it meant that there was time for the proper technical discussion normally expected at a CC meeting. He had asked Dr Gill if the JWGFS was concerned about the longer attendance that would be necessary if future CCL meetings were extended to cover several days of technical discussion and Dr Gill had thought that this would not be a problem. Anyway, once the JWGFS was more aligned with reporting to the CCTF, it was likely that only the chairmen would attend the CCL meetings, and full JWGFS attendance at the extended CCL meeting would not be necessary.

Dr Thalmann mentioned that the WGDM structure allows smaller laboratories to take part in all discussions because they happen at WGDM. If there are separate groups undertaking all these different roles, then either smaller laboratories will not be able to take part in all meetings due to budget restraints, or meetings will need to take place in series, thus extending the duration. He mentioned that outside the CCL and WGDM meetings a lot of coordination work was performed throughout the year by the WGDM Chairman, and it was not clear how this could be absorbed and taken onboard by the CCL directly since the CCL only came together at intervals.

Dr Brown was concerned that elevating the discussion groups to CCL Working Group status would require meetings to be held at the BIPM, to coincide with the CCL meeting. This precluded the groups such as the WGDM from holding meetings in the regions. He felt that holding WGDM meetings in the RMOs was beneficial as it allowed them greater access to the WGDM and allowed the WGDM members to see directly the work in the regions. He mentioned that originally the work of the CCL was mostly concerned with lasers and featured almost no dimensional metrology. Since then the CCL has become more concerned with dimensional metrology and this is why the WGDM's role has grown. When the Frequency Standards Group moves to report mostly to the CCTF, then the nature of the CCL will be quite different and this may be a better time to re-organize the structure.

Prof. Wallard added some comments. In his view effectively the CCL has one Working Group – the WGDM. A CIPM policy document exists which defines the structure and role of CCs, and the CCL does not conform to this. The WGDM is effectively becoming the CCL. The CIPM expects to see a Working Group in CCs to oversee the CIPM MRA work. It expects to see CC work on long-term strategy. What is left is the technical discussion of metrology needs in length. He agreed that Dr Brown's point concerning WGDM visiting regions to give better access is very relevant and the BIPM would try to support this activity, where possible. He felt it was not necessary to change the CCL immediately; it would be acceptable to take note of this discussion so far and to work towards a change of structure in the future. Dr Stone mentioned that this last comment was what the WGDM Chairman had proposed – considered opinion before changing the structure.

Dr Giardini commented that, as a new attendee at CCL, he could not comment on the previous work done by the WGDM, but that he saw some advantages in the new structure proposed by the NRC. Dr Bergmans thought that a lot of the changes were a consequence of the CCL moving from frequency to dimensional metrology so he thought some change was necessary. But he thought the CCL should be careful not to change so rapidly that things are missed or fall by the wayside.

Dr Riehle personally preferred not to have strategic planning groups in each CC but he recognized that the CCL was a CC of the CIPM and that the CIPM had issued instructions to the CCs to make such changes. Dr Wilkening noted that both presentations showed WGs with similar titles. However he was cautious of splitting the work into separate groups, because there was a risk with this. Although there would be some work in these groups outside formal meetings, he preferred to see the groups come together for longer discussions.

Dr Brown reiterated the point concerning the effects of transferring the coordination work thus far undertaken by the WGDM Chairman to the CCL itself. He suggested that in order to prepare for this, there was a need for offline discussion with the CCL President to work out the details. Dr Giardini was concerned that these discussions and any proposals that might be prepared would impact on the work of the CCL and he asked that, as a representative of his NMI, he be kept informed. Several Delegates also wished for transparency in any discussions on such proposals.

Dr Thomas commented that she attended several CCs and thought that the two proposals tabled were very similar. Her personal opinion was that several of the task forces proposed by Dr Thalmann were similar to the CC Working Groups requested by the CIPM. She remarked that the WGDM had been made aware earlier in the week of some new features of the JCRB

CMC website, whereas other CCs with explicit WGs on these topics had received this information some time ago.

Dr Thalmann explained that the proposals were deliberately similar in order to address the work, but different enough to allow for a smooth change from the existing structure to something of the future. He underlined the points of Dr Brown and Dr Wilkening to not require excessive travel by having many Working Groups meeting separately. He responded to Dr Thomas' point concerning the JCRB CMC website by saying that Dr Lewis had reported this to EURAMET TC-L some time ago. He summarized the discussion so far. The WGDM will address the problem and will collaborate with the CCL President and the BIPM Director so as to progress smoothly towards a future structure.

Dr Steele explained that he had reduced the number of Working Groups in the NRC proposal to address the issue of preventing excessive travel needs. He welcomed the cautious and smooth transition. He thought it was important that the CCL made concrete progress towards the requirements set out by the CIPM. Much of the work of the proposed Working Groups and task forces could be achieved away from face-to-face meetings.

The CCL President brought the agenda item to a close by inviting Prof. Wallard to prepare a summary of the discussions and a proposal on possible restructuring for submission to the next CCL meeting.

8 CREATION OF A WORKING GROUP ON CMCS

This had been discussed in Section 7.

9 NEW ORGANIZATION FOR CCL-K11

Dr Brown had presented the proposals within the JWGFS and these had been summarized in the presentations from Dr Gill and Dr Riehle. There was a draft protocol and the JWGFS wanted to involve the node laboratories in its revision. Prof. Wallard asked when the first measurements would begin. Dr Lassila responded that the GUM (Poland) had been having preliminary discussions about going to the MIKES (Finland) to undertake a comparison under CCL-K11.

Dr Gill mentioned that the three levels of techniques that had been presented for verifying combs were not part of the CCL-K11 protocol itself. However, the node laboratories needed to have used one of the comb validation techniques in order to satisfy the reviewers who would be accepting CMCs from the participating laboratories. He asked how the laboratories that had in-house combs were to assure the validity of their CMCs – would they need to make comparisons with the node laboratories (for CMCs operating near the highest level of the comb)? There should be some form of comparison to validate the comb; this should be against another standard through published data, for example agreement on the values of other standards.

BIPM.L-K11 should be concluded and marked as such in the KCDB and the pilot and protocol group should ensure that the details of the new comparison are sent to the KCDB coordinator.

Dr Stone had been asked to chair an *ad hoc* group on considering the inclusion of unstabilized lasers in the *Mise en pratique*. He presented a recommendation that was an output from the group:

> The Task Force on Unstabilized Lasers,
>
> **in response** to a instruction from the CCL at its meeting in 2005,
>
> **having reviewed** the question of including unstabilized lasers in the *Mise en pratique* for the definition of the metre,
>
> **considering**
> - that most laser interferometers used for length measurement are based on 633 nm He-Ne lasers,
> - that these interferometers are often used at uncertainty levels that are large compared to the possible variation of the He-Ne laser vacuum wavelength,
> - that it would be helpful to provide guidance and documentary evidence concerning the value of the vacuum wavelength and its uncertainty that can be expected in the absence of calibration,
>
> **recognizing**
> - that such evidence could help to avoid unnecessary calibrations of these lasers in such applications,
>
> **recommends** that an entry for unstabilized helium-neon lasers, operating at 633 nm (3s2→2p4), be included in the *Mise en pratique* for the definition of the metre, with text as given in the following paragraph, and that an accompanying paper with CCL authority be published in *Metrologia*.

The entry was to be supported by an article published in *Metrologia* that would give more details and explanations of the thinking behind the entry. The MeP text contained warnings about potential problems, for example presence of 640 nm radiation, what its effect would be, and how to test for it. The *ad hoc* group had been cautious not to leave the list open for many more values to be added, though it was possible to add more entries with sufficient justification. The group had easily reached consensus on the value of the wavelength and its uncertainty. Dr Stone continued that recently Prof. Wallard had informed the group about recent decisions across the CCs on the MeP texts that were to be prepared for the forthcoming redefinitions of several units and the consensus was that such MeP texts should only contain the highest quality values and methods. As such, the entry of the unstabilized lasers into the MeP was not in line with this consensus.

The reaction of the *ad hoc* group was that they were following their Terms of Reference. The group recalled that it had not been set up to address issues in other CCs but to address specific need of the length committee, and the consensus of the recent group meeting was that the result for the unstabilized lasers should enter the MeP or some similar document. Discussions earlier in this CCL meeting had suggested alternative documents may be needed for other reasons. The meeting needed to discuss where this new entry belonged. Dr Riehle and Dr Gill had no objections to this entering part 2 (the frozen part) of the new frequency list. The meeting agreed that this is where the entry should be made. Prof. Wallard asked if accreditors would accept this and Dr Brown responded that they already accepted lamps and this would be no worse than that

situation. The scope of the last paragraph in the Draft Recommendation, relating to stabilized 633 nm lasers, needed to be increased to include iodine-stabilized lasers. It was noted the wavelength was not given since this was the case for the lamp entries, but other lasers were listed with both frequency and wavelength values, so the new entry should be edited to contain both wavelength and frequency values.

The meeting agreed that the recommendation and the values given would enter the frequency list, and Dr Stone and the group would continue work on a paper for *Metrologia*. Dr Riehle commented that it would also be useful to put the paper on the BIPM website and to know the likely web address of the paper ready for the frequency list entry.

Dr Balling asked whether or not the 543 nm laser proposal from the CMI had been considered. Dr Stone responded that it had been discussed but the feeling was that it was too soon for this and would need further discussion.

10 DISCUSSION ON NEW OPTICAL STANDARDS AND COMPARISON TECHNIQUES

Prof. Wallard had seen some proposals for forming new Working Groups during a meeting in Turin but there had been no further discussions since then. He asked where the leading edge work on optical frequency standards was going and how they could make links outside of the NMI community. Would there be, for example, a possibility of linking to the GPS or using travelling standards to improve the international time scale? Dr Gill reported that at the CCTF meeting in 2006 a new Working Group had been established to look into techniques for comparing high-accuracy clocks. These included: a transportable clock, comparison of remote standards via optical fibre transmission, comparison via optical satellite links, or using improved microwave techniques. Optical fibre transmission techniques had already demonstrated extremely good results, but only within local fibre networks. Access to longer range fibre links was an issue. The improvement of TAI would need a redefinition of the SI second before optical clocks could contribute to TAI. Dr Madej suggested adding this at the appropriate time to the Terms of Reference of the JWGFS.

The changes to the JWGFS Terms of Reference would normally need endorsement by both the CCL and the CCTF, however the upcoming CIPM meeting in November 2007 would involve both the CCTF and CCL Presidents. The BIPM took an action to bring the two new Terms of Reference (3 and 4) of the JWGFS to the CIPM for approval by both Presidents. The BIPM would also look into the Terms of Reference of the relevant WG of the CCTF and consider if the Terms of Reference of the JWGFS should also include an item relating to interaction between the two groups.

11 PROPOSALS FOR NEW KEY COMPARISONS

The full list of CCL key comparisons was presented and agreed at agenda point 4 but is repeated here for reference.

CCL-K1	Gauge blocks up to 500 mm (including former CCL-K2)
CCL-K3	Angle standards (polygons and angle blocks)
CCL-K4	Cylindrical diameter standards
CCL-K5	Step gauge
CCL-K7	Line scales
CCL-K8	Surface texture standards
CCL-K11	MeP stabilized lasers, former BIPM.L-K11

12 REPORT AND DISCUSSION ON THE PROGRESS OF WORK AT THE BIPM

Prof. Wallard reported that much of the presentation for this agenda item had already been presented under agenda item 2. The BIPM had been given permission by the CIPM to continue to operate its femtosecond combs, but only for internal use, for example for the watt balance experiment, the calculable capacitor and the gravimeter comparisons (ICAG). The gas cell-filling service had been operated and would continue, though with less scope in materials other than iodine. The budget proposed to the CGPM allowed the current activities to be maintained, but with no expansion in operations.

13 FUTURE PRIORITIES TO BE ADDRESSED BY THE BIPM

Dr Lewis asked about the CIPM MRA website that would be set up to maintain an up-to-date list of CIPM and JCRB documents. Prof. Wallard hoped that it would gain approval from the CIPM in November 2007.

14 CCL MEMBERSHIP AND MEMBERSHIP OF WORKING GROUPS TERMS OF REFERENCE OF WORKING GROUPS

Two NMIs had asked for full membership of the CCL: the BEV (Austria), and the SPRING (Singapore). The President had examined the documents that they had submitted and recommended that the CCL support their application. The meeting agreed that the President should recommend to the CIPM their approval as full members.

The conclusion from the earlier agenda item discussions was that there would be no immediate change to the organization of the CCL or to the current Terms of Reference of the WGDM. The Terms of Reference of the JWGFS had two additional items that needed approval from the CCL and CCTF and the BIPM had already taken an action by approaching the CCL and CCTF Presidents.

Dr Riehle asked permission to use the extended mailing list of individuals for the JWGFS, rather than emailing just the NMIs. He noted that the CCTF had not named personal members of the Working Group. Dr Steele mentioned that members of Consultative Committees are formally the NMIs. Prof. Wallard added that the previous CCL minutes showed that the CCL had been asked by WGDM for clarification on matters of membership. The CIPM policy document *"CIPM Consultative Committees: General rules and policy"* stated that members of the Working Groups are individual experts. Dr Giardini mentioned that the NMIA was asked to nominate the representatives to the WGDM and this seemed contrary to the CIPM policy document.

Dr Thalmann mentioned the Terms of Reference of the WGDM had been discussed at the previous meeting of the CCL. In view of the forthcoming changes to the CCL, he did not wish to table any changes to the WGDM Terms of Reference at this time.

Dr Steele asked who was responsible for ensuring that the additional acetylene radiation, requested by Dr Thalmann, would be entered into the relevant part of the frequency list. Prof. Wallard responded that the specific additional radiation was requested by the WGDM and it was for the WGDM Chairman to ensure that it was entered into the frequency list. Dr Steele was concerned about the official route for this action as it seemed unclear how the dual Chairmanship of the JWGFS operated in this respect. Dr Gill responded that he was originally the Chairman of the CCL WGMeP and Dr Riehle was the Chairman of the CCTF Working Group on Secondary Realizations of the Second. These two groups had been merged and for the moment, the joint group had two chairmen. He thought that for updating some items, only one of the CCs (CCL or CCTF) would need to be consulted. For some other items both CCs would be consulted. Dr Steele asked how the CCL would submit to the JWGFS the frequencies of interest to the WGDM. Dr Gill responded that the interaction would occur through experts that were members of both the WGDM and the JWGFS and the Chairman of the WGDM would be kept informed.

There was some additional discussion on the possibility of a joint workshop between the CCTF and CCL and the BIPM took an action to take this forward, by discussion with Philippe Tuckey.

Prof. Wallard asked the Rapporteur to ensure that the minutes contained a list of actions from the meeting.

15 RECOMMENDATIONS TO THE CIPM

Dr Gill had mentioned that the JWGFS report to the CCL included some proposals for Recommendations to the CIPM. These were now shown in the official format, and discussed. There had been some changes since the original presentations to the meeting in earlier agenda items.

Dr Riehle was asked who would set up the source data for the entry on unstabilized lasers. Dr Stone replied that he had the data available. It was suggested that the paper describing the details, backgrounds and source data would first need approval by the CCL before being published in *Metrologia*. Prof. Wallard would liaise with the editor to clarify which part of the journal was the most appropriate for this publication.

The meeting agreed on all of these decisions and Recommendations. [The approved text is given at the end of this report].

16 OTHER BUSINESS

Nothing was tabled.

17 NEXT MEETING OF THE CCL

It had previously been suggested to have both the CCL and CCTF meetings at a similar time and the timing of this would be spring (northern hemisphere) 2008. The BIPM would consult with the CIPM to make the necessary arrangements.

The Chairman thanked all participants for a lively and very productive meeting. He announced that he would soon be retiring from the CIPM and therefore this 13th meeting of the CCL would be his final meeting as CCL President. He expressed his thanks for all of the work of the CCL during his presidency and wished all the Delegates a safe journey home.

On behalf of the meeting, Prof. Wallard thanked the President for his work on chairing the CCL, and highlighted Dr Chung's background in length metrology research.

The staff of the BIPM were thanked for their help during the meeting and behind the scenes.

The meeting was closed.

Dr A. Lewis, Rapporteur

RECOMMANDATIONS DU COMITÉ CONSULTATIF DES LONGUEURS

PRÉSENTÉES AU COMITÉ INTERNATIONAL DES POIDS ET MESURES

RECOMMENDATION CCL 1 (2007)
Révision de la liste des fréquences étalons

RECOMMANDATION CCL 1a (2007)*

Le Comité consultatif des longueurs,

considérant que

- l'on a déterminé des valeurs plus précises des fréquences de molécules dans le domaine des télécommunications optiques, valeurs déjà publiées dans la liste des fréquences étalons, à l'aide de peignes à impulsions femtosecondes ;
- l'on a déterminé, pour la première fois, les fréquences de molécules dans le domaine des télécommunications optiques, à l'aide de peignes à impulsions femtosecondes ;
- l'on a déterminé, pour la première fois, les fréquences de certaines transitions dans l'iode, en cellule, transitions proches de la radiation émise par l'étalon de fréquence optique à 532 nm, à l'aide de peignes à impulsions femtosecondes ;

propose que la liste des fréquences étalons soit révisée pour y inclure :

- les valeurs mises à jour des fréquences de la bande ($\nu_1 + \nu_3$) de $^{12}C_2H_2$, autour de 1,54 μm ;
- les valeurs des fréquences de la bande ($2\nu_1$) de $^{12}C_2HD$, autour de 1,54 μm ;
- les valeurs des fréquences des composantes hyperfines des transitions P(142) 37-0, R(121) 35-0 et R(85) 33-0 dans l'iode à 532 nm.

* Cette Recommandation a été adoptée par le CIPM comme Recommandation 1 (CI-2007), « Révision de la liste des radiations recommandées pour la mise en pratique de la définition du mètre », lors de sa 96e session en novembre 2007.

RECOMMANDATION CCL 1b (2007)

Le Comité consultatif des longueurs,

propose que le Comité international des poids et mesures adopte les valeurs des radiations suivantes, en addition à la liste des fréquences étalons :

- transitions de la bande ($2\nu_1$) de $^{12}C_2HD$, autour de 1,54 µm

		$\lambda \approx 1{,}54$ µm	**bande ($2\nu_1$)**	**$^{12}C_2HD$**	
J	f(P(J))/ kHz	u_c /kHz	J	f(R(J))/kHz	u_c /kHz
27	195 083 584 556	5	0	197 004 767 626	5
26	195 161 449 715	5	1	197 062 611 545	5
25	195 238 655 952	5	2	197 119 660 023	5
24	195 315 202 227	5	3	197 175 921 813	5
23	195 391 087 967	5	4	197 231 407 145	5
22	195 466 309 716	5	5	197 286 126 795	5
21	195 540 867 837	5	6	197 340 091 336	5
20	195 614 760 669	5	7	197 393 310 618	5
19	195 687 985 368	5	8	197 445 793 469	5
18	195 760 540 274	5	9	197 497 547 587	5
17	195 832 422 908	5	10	197 548 579 273	5
16	195 903 630 364	5	11	197 598 894 432	5
15	195 974 159 502	5	12	197 648 497 165	5
14	196 044 006 224	5	13	197 697 391 167	5
13	196 113 166 245	5	14	197 745 579 093	5
12	196 181 634 239	5	15	197 793 063 418	5
11	196 249 404 477	5	16	197 839 845 665	5
10	196 316 469 424	5	17	197 885 927 073	5
9	196 382 821 148	5	18	197 931 308 538	5
8	196 448 450 320	5	19	197 975 990 084	5
7	196 513 346 479	5	20	198 019 972 926	5
6	196 577 498 143	5	21	198 063 257 107	5
5	196 640 893 107	5	22	198 105 840 645	5
4	196 703 518 964	5	23	198 147 725 370	5
3	196 765 363 848	5	24	198 188 910 239	5
2	196 826 417 377	5	25	198 229 394 675	5
1	196 886 671 626	5	26	198 269 179 255	5
			27	198 308 261 614	6

Écarts de fréquence des composantes hyperfines des transitions P(142) 37-0, R(121) 35-0 et R(85) 33-0 dans l'iode, à 532 nm, par rapport à la fréquence recommandée de $^{127}I_2$, transition R(56) 32-0, composante a_{10}

- f_{a1} [P(142) 37-0] - f_{a10} [R(56) 32-0] = 20 123 511,4 (5,0) kHz

Séparations hyperfines de la transition P(142) 37-0

Composante hyperfine	Observée (kHz)
a_1	0
a_2	201 862,3
a_3	266 700,6
a_4	302 571,3
a_5	361 836,0
a_6	366 696,9
a_7	386 204,6
a_8	467 369,1
a_9	491 394,9
a_{10}	569 318,6
a_{11}	669 162,1
a_{12}	688 963,6
a_{13}	734 239,7
a_{14}	754 848,4
a_{15}	854 522,3

- f_{a1} [R(121) 35-0] - f_{a10} [R(56) 32-0] = 27 539 228,6 (5,0) kHz

Séparations hyperfines de la transition R(121) 35-0

Composante hyperfine	Observée (kHz)
a_1	0
a_2	78 094,0
a_3	154 328,5
a_4	291 034,5
a_5	351 499,2
a_6	374 970,5
a_7	433 704,3
a_8	456 783,2
a_9	476 593,6
a_{10}	534 662,3
a_{11}	553 248,7
a_{12}	594 812,8
a_{13}	648 394,2
a_{14}	702 090,3
a_{15}	749 153,7
a_{16}	773 429,2
a_{17}	808 079,0
a_{18}	831 410,9
a_{19}	914 362,6
a_{20}	932 813,8
a_{21}	952 564,0

- f_{a1} [R(85) 33-0] - f_{a10} [R(56) 32-0] = 46 496 559,1 (5,0) kHz

Séparations hyperfines de la transition R(85) 33-0

Composante hyperfine	Observée (kHz)
a_1	0
a_2	50 732,5
a_3	99 742,3
a_4	281 946,2
a_5	331 678,7
a_6	341 087,6
a_7	389 099,9
a_8	445 205,3
a_9	461 608,4
a_{10}	496 293,9
a_{11}	510 619,4
a_{12}	582 132,0
a_{13}	621 988,5
a_{14}	662 825,5
a_{15}	729 463,3
a_{16}	751 718,8
a_{17}	777 078,3
a_{18}	798 584,8
a_{19}	892 318,3
a_{20}	906 642,5
a_{21}	922 692,5

De plus, le CCL **propose** que le CIPM adopte les valeurs mises à jour des transitions suivantes de la liste des fréquences étalons :

- transitions de la bande (ν1 + ν3) de $^{12}C_2H_2$, autour de 1,54 μm

		$\lambda \approx 1{,}54$ μm	**bande ($\nu_1 + \nu_3$)**	**$^{12}C_2H_2$**	
J	f(P(J))/ kHz	u_c /kHz	J	f(R(J))/kHz	u_c /kHz
31	194 018 374 094	12	0	196 627 647 485	5
30	194 111 459 735	6	1	196 696 652 918	6
29	194 203 815 938	5	2	196 764 884 467	9
28	194 295 440 629	6	3	196 832 341 007	5
27	194 386 332 284	6	4	196 899 021 426	8
26	194 476 488 865	7	5	196 964 924 625	5
25	194 565 910 191	5	6	197 030 049 517	6
24	194 654 593 133	7	7	197 094 395 033	5
23	194 742 536 723	5	8	197 157 960 117	5
22	194 829 739 418	6	9	197 220 743 737	5
21	194 916 199 701	6	10	197 282 744 858	5
20	195 001 916 075	5	11	197 343 962 482	5
19	195 086 887 065	5	12	197 404 395 609	9
18	195 171 111 207	5	13	197 464 043 280	7
17	195 254 587 067	8	14	197 522 904 510	5
16	195 337 313 210	6	15	197 580 978 379	5
15	195 419 288 236	6	16	197 638 263 952	8
14	195 500 510 746	9	17	197 694 760 326	5
13	195 580 979 370	10	18	197 750 466 614	5
12	195 660 692 742	9	19	197 805 381 943	5
11	195 739 649 524	9	20	197 859 505 462	5
10	195 817 848 379	11	21	197 912 836 343	6
9	195 895 288 002	8	22	197 965 373 772	6
8	195 971 967 085	7	23	198 017 116 975	5
7	196 047 884 351	9	24	198 068 064 596	6
6	196 123 038 520	5	25	198 118 217 440	5
5	196 197 428 347	10	26	198 167 573 369	5
4	196 271 052 580	5	27	198 216 132 108	6
3	196 343 910 002	8	28	198 263 892 859	17
2	196 415 999 395	5	29	198 310 855 386	7
1	196 487 319 562	5	30	198 357 019 564	27
			31	198 402 374 897	14

Recommandation CCL 2 (2007)

Le Comité consultatif des longueurs (CCL) et le Comité consultatif du temps et des fréquences (CCTF),

considérant que

- les missions suivantes ont été acceptées par le CCTF et recommandées par le Comité international des poids et mesures, au cours de leurs sessions respectives en 2006 :
  1. de faire, au CCL, les recommandations en ce qui concerne les radiations utiles à la réalisation pratique de la définition du mètre et de faire, au CCTF, les recommandations en ce qui concerne les radiations utilisables comme représentations secondaires de la seconde ;
  2. de maintenir avec le BIPM, la liste des valeurs des fréquences étalons recommandées et la liste des valeurs des longueurs d'onde étalons recommandées pour les applications incluant la réalisation pratique de la définition du mètre et les représentations secondaires de la seconde ;
- les (deux) missions suivantes ont été définies par le Groupe de travail commun au CCL et au CCTF sur les étalons de fréquence (CCL-CCTF FSWG), lors de sa réunion de 2007 :
  3. de prendre la responsabilité des comparaisons clés telles que CCL-K11 ;
  4. de répondre aux besoins futurs du CCL et du CCTF en ce qui concerne les fréquences étalons propres à chaque communauté ;
- Le point 3 concernant les missions du CCL-CCTF FS WG est particulièrement adapté à la conduite de la comparaison clé CCL-K11 ;

propose que le CIPM recommande que ces deux nouveaux points soient ajoutés aux missions déjà existantes du Groupe de travail commun au CCL et au CCTF sur les étalons de fréquence.

Recommandation CCL 3 (2007)*

Le Comité consultatif des longueurs,

considérant

- que la plupart des interféromètres lasers et beaucoup d'autres instruments de mesure de longueur utilisent des lasers à He-Ne à 633 nm, non asservis ;
- que ces appareils sont souvent utilisés à des niveaux d'incertitude bien plus grands que celui engendré par les variations possibles de longueur d'onde dans le vide du laser à He-Ne à 633 nm, non asservi ;
- que la variation de la longueur d'onde dans le vide du laser à He-Ne à 633 nm, non asservi, est strictement limitée par les phénomènes fondamentaux quantiques ;

reconnaissant

- qu'il serait nécessaire de fournir un guide d'application documenté concernant la valeur de la longueur d'onde dans le vide et son incertitude que l'on est supposé obtenir en l'absence d'étalonnage ;
- qu'un tel guide pourrait aider à éviter des étalonnages inutiles de ces lasers dans ce type d'applications ;

recommande

- que les valeurs $f = 473{,}612\ 7$ THz
  $\lambda = 632{,}990\ 8$ nm

  avec une incertitude-type relative de $1{,}5 \times 10^{-6}$, s'appliquent à la radiation dans le vide d'un laser à hélium-néon non asservi, opérant exclusivement sur la transition $3s_2 \rightarrow 2p_4$, indépendamment du mélange isotopique du néon ;
- que le laser à He-Ne à 633 nm, non asservi, opérant sur la transition $3s_2 \rightarrow 2p_4$, soit inclus dans la seconde catégorie de la liste *des fréquences étalons* et, qu'un article soit publié dans *Metrologia*, sous l'autorité du CCL.

* Cette Recommandation a été adoptée par le CIPM comme Recommandation 2 (CI-2007), « Sur la valeur et l'incertitude des lasers à He-Ne non asservis », lors de sa 96e session en novembre 2007.

RECOMMENDATIONS OF THE CONSULTATIVE COMMITTEE FOR LENGTH

SUBMITTED TO THE INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES

RECOMMENDATION CCL 1 (2007): Revision of the list of standard frequencies

RECOMMENDATION CCL 1a (2007)*

The Consultative Committee for Length,

considering that:

- improved frequency values of molecules in the optical telecommunications region, already documented in the list of standard frequencies, have been determined by femtosecond comb-based frequency measurements;
- frequencies of molecules in the optical telecommunications region have been determined by femtosecond comb-based frequency measurements for the first time;
- frequencies of certain iodine gas-cell absorptions close to the 532 nm optical frequency standard have been determined by femtosecond comb-based frequency measurements for the first time;

proposes that the list of standard frequencies be revised to include the following:

- an updated list of frequency values for the $^{12}C_2H_2$ ($\nu_1 + \nu_3$) band at 1.54 μm;
- the addition of frequency values for the $^{12}C_2HD$ ($2\nu_1$) band at 1.54 μm;
- the addition of frequency values for the hyperfine components of the P(142) 37-0, R(121) 35-0 and R(85) 33-0 iodine absorptions at 532 nm.

* This Recommendation was adopted as Recommendation 1 (CI-2007) by the CIPM at its 96th meeting in November 2007, with the title "Revision of the *Mise en pratique* list of recommended radiations".

RECOMMENDATION CCL 1b (2007)

The Consultative Committee for Length,

proposes that the CIPM adopt the following radiation values for addition to the list of standard frequencies:

- $^{12}C_2HD$, (2ν1) band at 1.54 μm

		$\lambda \approx 1.54$ μm	$(2\nu_1)$ band	$^{12}C_2HD$	
J	f(P(J))/kHz	u_c /kHz	J	f(R(J))/kHz	u_c /kHz
27	195 083 584 556	5	0	197 004 767 626	5
26	195 161 449 715	5	1	197 062 611 545	5
25	195 238 655 952	5	2	197 119 660 023	5
24	195 315 202 227	5	3	197 175 921 813	5
23	195 391 087 967	5	4	197 231 407 145	5
22	195 466 309 716	5	5	197 286 126 795	5
21	195 540 867 837	5	6	197 340 091 336	5
20	195 614 760 669	5	7	197 393 310 618	5
19	195 687 985 368	5	8	197 445 793 469	5
18	195 760 540 274	5	9	197 497 547 587	5
17	195 832 422 908	5	10	197 548 579 273	5
16	195 903 630 364	5	11	197 598 894 432	5
15	195 974 159 502	5	12	197 648 497 165	5
14	196 044 006 224	5	13	197 697 391 167	5
13	196 113 166 245	5	14	197 745 579 093	5
12	196 181 634 239	5	15	197 793 063 418	5
11	196 249 404 477	5	16	197 839 845 665	5
10	196 316 469 424	5	17	197 885 927 073	5
9	196 382 821 148	5	18	197 931 308 538	5
8	196 448 450 320	5	19	197 975 990 084	5
7	196 513 346 479	5	20	198 019 972 926	5
6	196 577 498 143	5	21	198 063 257 107	5
5	196 640 893 107	5	22	198 105 840 645	5
4	196 703 518 964	5	23	198 147 725 370	5
3	196 765 363 848	5	24	198 188 910 239	5
2	196 826 417 377	5	25	198 229 394 675	5
1	196 886 671 626	5	26	198 269 179 255	5
			27	198 308 261 614	6

Hyperfine components of the P(142) 37-0, R(121) 35-0 and R(85) 33-0 absorptions at 532 nm

- f_{a1} [P(142) 37-0] - f_{a10} [R(56) 32-0] = 20 123 511.4 (5.0) kHz

Hyperfine splittings of the P(142) 37-0 transition

Hyperfine component	Observed (kHz)
a_1	0
a_2	201 862.3
a_3	266 700.6
a_4	302 571.3
a_5	361 836.0
a_6	366 696.9
a_7	386 204.6
a_8	467 369.1
a_9	491 394.9
a_{10}	569 318.6
a_{11}	669 162.1
a_{12}	688 963.6
a_{13}	734 239.7
a_{14}	754 848.4
a_{15}	854 522.3

- f_{a1} [R(121) 35-0] - f_{a10} [R(56) 32-0] = 27 539 228.6 (5.0) kHz

Hyperfine splittings of the R(121) 35-0 transition

Hyperfine component	Observed (kHz)
a_1	0
a_2	78 094.0
a_3	154 328.5
a_4	291 034.5
a_5	351 499.2
a_6	374 970.5
a_7	433 704.3
a_8	456 783.2
a_9	476 593.6
a_{10}	534 662.3
a_{11}	553 248.7
a_{12}	594 812.8
a_{13}	648 394.2
a_{14}	702 090.3
a_{15}	749 153.7
a_{16}	773 429.2
a_{17}	808 079.0
a_{18}	831 410.9
a_{19}	914 362.6
a_{20}	932 813.8
a_{21}	952 564.0

- f_{a1} [R(85) 33-0] - f_{a10} [R(56) 32-0] = 46 496 559.1 (5.0) kHz

Hyperfine splittings of the R(85) 33-0 transition

Hyperfine component	Observed (kHz)
a_1	0
a_2	50 732.5
a_3	99 742.3
a_4	281 946.2
a_5	331 678.7
a_6	341 087.6
a_7	389 099.9
a_8	445 205.3
a_9	461 608.4
a_{10}	496 293.9
a_{11}	510 619.4
a_{12}	582 132.0
a_{13}	621 988.5
a_{14}	662 825.5
a_{15}	729 463.3
a_{16}	751 718.8
a_{17}	777 078.3
a_{18}	798 584.8
a_{19}	892 318.3
a_{20}	906 642.5
a_{21}	922 692.5

In addition, the CCL **proposes** that the CIPM adopt the following updated radiation values to the list of standard frequencies:

- $^{12}C_2H_2$, (ν1 + ν3) band at 1.54 μm:

		$\lambda \approx 1.54$ μm	**($\nu_1 + \nu_3$) band**	**$^{12}C_2H_2$**	
J	f(P(J))/ kHz	u_c / kHz	J	f(R(J))/ kHz	u_c / kHz
31	194 018 374 094	12	0	196 627 647 485	5
30	194 111 459 735	6	1	196 696 652 918	6
29	194 203 815 938	5	2	196 764 884 467	9
28	194 295 440 629	6	3	196 832 341 007	5
27	194 386 332 284	6	4	196 899 021 426	8
26	194 476 488 865	7	5	196 964 924 625	5
25	194 565 910 191	5	6	197 030 049 517	6
24	194 654 593 133	7	7	197 094 395 033	5
23	194 742 536 723	5	8	197 157 960 117	5
22	194 829 739 418	6	9	197 220 743 737	5
21	194 916 199 701	6	10	197 282 744 858	5
20	195 001 916 075	5	11	197 343 962 482	5
19	195 086 887 065	5	12	197 404 395 609	9
18	195 171 111 207	5	13	197 464 043 280	7
17	195 254 587 067	8	14	197 522 904 510	5
16	195 337 313 210	6	15	197 580 978 379	5
15	195 419 288 236	6	16	197 638 263 952	8
14	195 500 510 746	9	17	197 694 760 326	5
13	195 580 979 370	10	18	197 750 466 614	5
12	195 660 692 742	9	19	197 805 381 943	5
11	195 739 649 524	9	20	197 859 505 462	5
10	195 817 848 379	11	21	197 912 836 343	6
9	195 895 288 002	8	22	197 965 373 772	6
8	195 971 967 085	7	23	198 017 116 975	5
7	196 047 884 351	9	24	198 068 064 596	6
6	196 123 038 520	5	25	198 118 217 440	5
5	196 197 428 347	10	26	198 167 573 369	5
4	196 271 052 580	5	27	198 216 132 108	6
3	196 343 910 002	8	28	198 263 892 859	17
2	196 415 999 395	5	29	198 310 855 386	7
1	196 487 319 562	5	30	198 357 019 564	27
			31	198 402 374 897	14

RECOMMENDATION CCL 2 (2007)

The Consultative Committee for Length and the Consultative Committee for Time and Frequency,

considering that:

- the following Terms of Reference have been accepted by the CCTF and recommended by the CIPM at their respective 2006 meetings:
  1. To make recommendations to the CCL for radiations to be used for the realization of the definition of the metre and to make recommendations to the CCTF for radiations to be used as secondary representations of the second;
  2. To maintain together with the BIPM the list of recommended frequency standard values and wavelength values for applications including the practical realization of the definition of the metre and secondary representations of the second;
- the following Terms of Reference have been drafted by the CCL-CCTF Frequency Standards Working Group (CCL-CCTF FS WG) at their 2007 meeting:
  3. To take responsibility for key comparisons of standard frequencies such as CCL-K11;
  4. To respond to future needs of both the CCL and CCTF concerning standard frequencies relevant to the respective communities;
- item 3 of Terms of Reference of the CCL-CCTF FS WG is particularly relevant to the conduction of the CCL-K11 key comparison;

propose that the CIPM recommend that these two new items be added to the existing Terms of Reference of the CCL-CCTF FS WG.

RECOMMENDATION CCL 3 (2007)*

The Consultative Committee for Length,

considering

- that most laser interferometers and many other measuring instruments used for length measurement are based on 633 nm He-Ne lasers;
- that these instruments are often used at uncertainty levels that are large compared to the possible variation of the He-Ne laser vacuum wavelength;
- that the vacuum wavelength of the unstabilized 633 nm He-Ne laser is restricted to within a narrow range by fundamental quantum phenomena;

recognizing

- that it would be necessary to provide guidance and documentary evidence concerning the value of the vacuum wavelength and its uncertainty that can be expected in the absence of calibration;
- that such evidence could help to avoid unnecessary calibrations of these lasers in such applications;

recommends

- that the values $f = 473.612\ 7$ THz
  $\lambda = 632.990\ 8$ nm

  with a relative standard uncertainty of 1.5×10^{-6}, apply to the radiation in vacuum of a unstabilised helium-neon laser operating solely on the $3s_2 \rightarrow 2p_4$ transition, independent of the isotopic mixture of the neon;
- that an entry for unstabilized helium-neon lasers, operating on the 633 nm ($3s_2 \rightarrow 2p_4$) neon transition, be included in the second category of the list of standard frequencies, and that an accompanying paper with CCL authority be published in *Metrologia*.

* This Recommendation was adopted as Recommendation 2 (CI-2007) by the CIPM at its 96th meeting in November 2007, with the title "On the value and uncertainty of unstabilised He-Ne lasers".

APPENDIX L 1.

Working documents submitted to the CCL at its 13th meeting

Open working documents of the CCL can be obtained from the BIPM in their original version, or can be accessed on the BIPM website:

http://www.bipm.org/cc/AllowedDocuments.jsp?cc=CCL

Documents restricted to Committee Members can be accessed at the restricted website.

Document CCL	
07-00	CCL. — Draft Agenda, 1 p. (access restricted)
07-01	BIPM/CCL. — Report of the 12th Meeting of the CCL, 74 pp.
07-02	WGDM. — Report of the 12th Meeting of the CCL-WGDM (September 2007), A. Lewis, 25 pp. (also document CCL/WGDM/07-53-Final)
07-03	CCL-CCTF FSWG. — Report of the Meeting of the CCL-CCTF Frequency Standards Working Group (September 2007), P. Gill, L. Robertsson, 7 pp.
07-04	WGDM. — The CCL Comparison Scheme, 3 pp. (also document CCL/WGDM/07-01) (access restricted)
07-05	WGDM. — WGDM Comments on Minutes of 2006 CIPM Meeting, 2 pp. (also document CCL/WGDM/07-06) (access restricted)
07-06	WGDM. — Running of MRA Comparisons in Length Metrology and Monitoring their Impact on CMCs, A. Lewis, 6 pp. (also document CCL/WGDM/07-41) (access restricted)
07-07	CCL. — Proposal for Revised Working Group Structure for CCL, A. Steele, J. Pekelsky, 5 pp. (access restricted)

APPENDIX L 2.

Liste de décisions prises par le CCL lors de sa 13e session

Résumé des décisions prises par le CCL lors de sa 13e session : décisions officielles présentées au point 15 de l'ordre du jour et décisions prises dans le cadre des autres points de l'ordre du jour.

DÉCISIONS OFFICIELLES

DÉCISION CCL 1 (2007)

Le Comité consultatif des longueurs,

considérant que

- une inconsistance a été détectée dans la spécification de la valeur de l'amplitude de modulation nécessaire à la stabilisation du laser étalon à 1,54 μm, à l'aide de la transition $^{13}C_2H_2$ ($\nu_1 + \nu_3$) P(16) de l'acétylène ;
- les spécifications des caractéristiques de la modulation nécessaire à la stabilisation d'un laser à 543 nm, à l'aide de la composante b_{10} de la transition R(106) 28-0 de $^{127}I_2$, ne prennent pas en compte les techniques de modulation différentes de la détection 3*f* ;

décide que

- la largeur de modulation, spécifique à la stabilisation du laser étalon à 1,54 μm à l'aide de la transition $^{13}C_2H_2$ ($\nu_1 + \nu_3$) P(16) de l' acétylène, est modifiée comme suit :

  amplitude de modulation, crête à creux, de (1,5 $\pm$ 0,5) MHz (dans le cas de la détection 3*f*),
- la largeur de modulation du laser à 543 nm asservi sur la transition R(106) 28-0 dans $^{127}I_2$, telle que spécifiée dans la liste des fréquences étalons, est suivie de la phrase suivante :

  « D'autres techniques telles que la spectroscopie par bandes latérales en modulation de phase/fréquence ou la spectroscopie par transfert de modulation peuvent être utilisées sous réserve que le laser étalon ainsi réalisé produise la fréquence et son exactitude spécifiées dans la liste des fréquences étalons. »

DÉCISION CCL 2 (2007)

Le Comité consultatif des longueurs, sur les conseils du Groupe de travail commun CCL-CCTF sur les étalons de fréquence,

considérant que

- l'introduction des peignes à impulsions femtosecondes pour les mesures des fréquences optiques a réduit le besoin des lasers stabilisés en fréquence dans le moyen infrarouge et l'infrarouge lointain ;

- la composante $F_2^{(2)}$ de la transition P(7) de la bande ν_3 du méthane dont la structure magnétique hyperfine n'est pas résolue, à 3,39 μm, est une de ces fréquences recommandées ;
- les transitions dans OsO_4 en coïncidence avec la raie du laser à CO_2, autour de 10 μm, font partie également de ces fréquences recommandées ;

décide que la composante $F_2^{(2)}$, dont la structure hyperfine magnétique n'est pas résolue, de la transition P(7) de la bande ν_3 du méthane, à 3,39 μm, et les transitions dans OsO_4, autour de 10 μm, sont placées dans la deuxième catégorie de la liste des fréquences étalons.

List of decisions made by the CCL at its 13th meeting

This list is a summary of the decisions made by the CCL at its 13th meeting, both formal decisions presented during agenda item 15, and decisions made during other agenda items.

OFFICIAL DECISIONS

DECISION CCL 1 (2007)

The Consultative Committee for Length,

considering that:

- an inconsistency has been detected in the specified frequency modulation width required to realise the acetylene $^{13}C_2H_2$ (ν1 + ν3) P(16) stabilised laser frequency standard at 1.54 mm;
- the frequency modulation conditions appropriate for laser stabilisation to the b_{10} component of the $^{127}I_2$ R(106) 28-0 transition at 543 nm do not take account of detection techniques different to 3*f* detection

decides that:

- the frequency modulation width relevant to the acetylene $^{13}C_2H_2$ (ν1 + ν3) P(16) stabilised laser frequency standard at 1.54 mm is changed to:

  frequency modulation width, peak-to-peak of 1.5 $\pm$ 0.5 MHz (for 3*f* detection cases)
- the following sentence is added after the stated frequency modulation width relevant to the $^{127}I_2$ R(106) 28-0 transition at 543 nm:

  "Other techniques such as FM side band spectroscopy or modulation transfer spectroscopy can be used to realise the standard, provided the value can be shown to remain within the stated uncertainty".

DECISION CCL 2 (2007)

The Consultative Committee for Length**,** on the advice of the CCL-CCTF Working Group on Frequency Standards,

considering that:

- the introduction of femtosecond combs for optical frequency measurement has resulted in the lack of requirement for mid and far infra-red stabilised laser frequencies;
- the methane unresolved hyperfine $F_2^{(2)}$ component, P(7) ν_3 transition at 3.39 μm is one such transition;
- the OsO_4 transitions co-incident with the CO_2 laser line at μm are also such transitions;

decides that the unresolved methane transition at 3.39 μm, and the OsO_4 transitions at 10 μm, are placed within the second category of the list of standard frequencies.

Decisions of the CCL made during agenda item discussions (in English only)

The CCL **approved** the re-titling of key comparison CCL-K8 to be 'Surface texture standards'. The portfolio of CCL key comparisons is thus:

CCL-K1	Gauge blocks up to 500 mm (including former CCL-K2)
CCL-K3	Angle standards (polygons and angle blocks)
CCL-K4	Cylindrical diameter standards
CCL-K5	Step gauge
CCL-K7	Line scales
CCL-K8	Surface texture standards
CCL-K11	MeP stabilized lasers, former BIPM.L-K11

The CCL **decided** that the JWGFS take responsibility for comparison CCL-K11.

The CCL **decided** that the WGDM take responsibility for coordinating the CMC review for comb based frequency calibrations.

The CCL **agreed** on the frequency and the uncertainty value given for unstabilized 633 nm He-Ne lasers as proposed by the CCL *ad hoc* group.

The CCL **decided** that the best location for the text containing the agreed frequency and uncertainty of the 633 nm unstabilized lasers would be in part 2 (the 'frozen' part) of the JWGFS frequency list and that this entry would contain both a frequency and a wavelength value.

The CCL **decided** that the more detailed text relating to the use of 633 nm unstabilized lasers should be published in a paper in *Metrologia*.

The CCL **decided** that the WGDM take responsibility for the preparation of a CCL document to contain the values from Appendix 2 of the JWGFS frequency list, (including the approved text relating to the use of unstabilized lasers in dimensional metrology) and the proposed new

standards for nanometrology – these items being the realizations of the metre of importance to work in dimensional metrology.

The CCL **decided** that comparison BIPM.L-K11 should be concluded and marked as such in the KCDB.

The CCL **approved** the applications made by BEV (Austria) and SPRING (Singapore) to become full members of the CCL.

The CCL **decided** that there would be no immediate change to the organization of the CCL or to the current Terms of Reference of the WGDM, which had been discussed at the previous meeting of the CCL.

The CCL **agreed** to the two additional Terms of Reference proposed by the JWGFS (items 3 and 4). These additional Terms of reference require additional approval by the CCTF.

APPENDIX L 3.
List of actions resulting from the 13th meeting of the CCL

This is a list of the actions decided upon during the 13th meeting of the CCL.

A.1 WGDM to request advice from JWGFS regarding the new categories to be added to the DimVIM concerning comb based frequency calibrations.

A.2 WGDM to review the proposed JWGFS single frequency list and suggest any additions to the list required for satisfying the needs of dimensional metrology.

A.3 WGDM to ensure that document WGDM-07-06 '*WGDM responses to CIPM*' to is placed on the WGDM web site and forwarded to CCL President and BIPM Director.

A.4 WGDM task force and BIPM to co-author a paper, based on document WGDM-07-01 '*CCL comparison scheme*' and ensure that the paper is ready before the 2008 meeting of the CIPM.

A.5 WGDM Chairman to ensure the WGDM report to CCL is made available on the CCL and WGDM document servers.

A.6 BIPM to approach CIPM to propose co-locating, in time, the future meetings of the CCL and CCTF, to enable a JWGFS meeting to happen immediately before the meetings of the two CCs. The suggested date for the first of these co-located meetings was June-July 2009.

A.7 Dr Robertsson and the CCL-K11 pilot and node laboratories to refine the protocol for the CCL-K11 comparison.

A.8 WGDM to prepare a document, under authority of the CCL, to contain the values from Appendix 2 of the JWGFS frequency list, the approved text relating to the use of unstabilized lasers in dimensional metrology. and the proposed new standards for nanometrology.

A.9 BIPM Director to prepare a summary of the discussion on the organization of the CCL and its Working Groups, and a proposal on a possible restructuring, for submission to the next CCL meeting.

A.10 KCDB coordinator to note the decision regarding the conclusion of comparison BIPM.L-K11 and to mark the comparison in the KCDB as ended.

A.11 Dr Stone, and the ad hoc group on the use of 633 nm unstabilized lasers, to prepare a paper on their work for publication in *Metrologia*.

A.12 BIPM to bring to the attention of the CIPM, at its meeting in 2007, the two new Terms of Reference (numbers 3 and 4) proposed for and by the JWGFS, and to ask the CCL and CCTF Presidents for their approval.

A.13 BIPM to consider if the Terms of Reference for the JWGFS should also include an item relating to interaction between the JWGFS and the CCTF Working Group on comparison of high accuracy clocks.

A.14 WGDM Chairman to request the JWGFS to include details of the acetylene stabilized 1.5 µm radiation in the JWGFS frequency list.

A.15 BIPM to take forward, via discussion with Philipe Tuckey, the possibility of a joint workshop between the CCL and the CCTF.

APPENDIX L 4.

Report of the meeting of the CCL-CCTF Frequency Standards Working Group
BIPM, Sèvres, 10-11 September 2007

See Document CCL/07-03

APPENDIX L 5.

Report of the meetings of the Working Group on Dimensional Metrology

CENAM, Querétaro, 30-31 October 2006
BIPM, Sèvres, 11-12 September 2007

See WGDM/minu-11 (2006) and WGDM/minu-12 (2007) (also Document CCL/07-02)