Bureau International des Poids et Mesures

Consultative Committee for Ionizing Radiation (CCRI)

Report of the 21st meeting
(19 June 2009)
to the International Committee for Weights and Measures

Comité international des poids et mesures

Note:

Following a decision of the International Committee for Weights and Measures at its 92nd meeting (October 2003), reports of meetings of the Consultative Committees are now published only on the BIPM website and in the form presented here.

Full bilingual versions in French and English are no longer published.

A.J. Wallard
Director BIPM

LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR IONIZING RADIATION

as of 19 June 2009

President

K. Carneiro, member of the International Committee for Weights and Measures.

Executive Secretary

P.J. Allisy-Roberts, International Bureau of Weights and Measures [BIPM], Sèvres.

Members

The Chairman of Section I.

The Chairman of Section II.

The Chairman of Section III.

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

Section I: x- and γ-rays, electrons

Chairman

P. Sharpe, National Physical Laboratory, Teddington.

Members

Australian Radiation Protection and Nuclear Safety Agency [ARPANSA], Yallambie.

Bundesamt für Eich- und Vermessungswesen [BEV], Vienna.

Central Office of Measures/Glówny Urzad Miar [GUM], Warsaw.

Commissariat à l'Énergie Atomique/Laboratoire National Henri Becquerel [LNE-LNHB], Gif-sur-Yvette.

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

Ente per le Nuove Technologie, l'Energia e l'Ambiente, Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti [ENEA-INMRI], Rome.

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

Hungarian Trade Licensing Office [MKEH], Budapest.

International Commission on Radiation Units and Measurements [ICRU].

National Institute of Metrology [NIM], Beijing.

National Institute of Standards and Technology [NIST], Gaithersburg.

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

National Physical Laboratory [NPL], Teddington.

National Research Council of Canada [NRC], Ottawa.

VSL [VSL], Delft.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

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

Observers

Comisión Nacional de Energía Atómica [CNEA], Buenos Aires.

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

International Atomic Energy Agency [IAEA], Vienna.

International Organization for Medical Physics [IOMP].

International Radioprotection Association [IRPA].

National Laboratory for Metrology of Ionizing Radiation, Institute of Radiation Protection and Dosimetry CNEN/Laboratório Nacional de Metrologia das Radiações Ionizantes, Instituto de Radioproteçao e Dosimetria [LNMRI-IRD], Rio de Janeiro.

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

Swedish Radiation Protection Authority [SSI], Stockholm.

Section II: measurement of radionuclides

Chairman

B.R.S. Simpson, National Metrology Institute of South Africa, Cape Town.

Members

Australian Nuclear Science and Technology Organisation [ANSTO], Menai.

Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas [CIEMAT], Madrid.

Commissariat à l'Énergie Atomique/Laboratoire National Henri Becquerel [LNE-LNHB], Gif-sur-Yvette.

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

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

Ente per le Nuove Technologie, l'Energia e l'Ambiente, Istituto Nazionale di Metrologia delle Radiazioni Ionizzanti [ENEA-INMRI], Rome.

"Horia Hulubei" National Institute of Physics and Nuclear Engineering [IFIN-HH], Bucharest-Magurele.

Hungarian Trade Licensing Office [MKEH], Budapest.

Institut de Radiophysique Appliquée [IRA], Lausanne.

Institute for Reference Materials and Measurements [IRMM], Geel.

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

National Institute of Metrology [NIM], Beijing.

National Institute of Standards and Technology [NIST], Gaithersburg.

National Laboratory for Metrology of Ionizing Radiation, Institute of Radiation Protection and Dosimetry CNEN/Laboratório Nacional de Metrologia das Radiações Ionizantes, Instituto de Radioproteçao e Dosimetria [LNMRI-IRD], Rio de Janeiro.

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

National Metrology Institute of South Africa [NMISA], Cape Town.

National Physical Laboratory [NPL], Teddington.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

Radioisotope Centre Polatom [RC], Swierk.

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

Observers

Bhabba Atomic Research Center [BARC], Mumbai.

Bundesamt für Eich- und Vermessungswesen [BEV], Vienna.

Comisión Nacional de Energía Atómica [CNEA], Buenos Aires.

International Atomic Energy Agency [IAEA].

International Commission on Radiation Units and Measurements [ICRU].

International Organization for Medical Physics [IOMP].

International Radioprotection Association [IRPA].

National Research Council of Canada [NRC], Ottawa.

VSL [VSL], Delft.

Section III: neutron measurements

Chairman

D. Thomas, National Physical Laboratory, Teddington.

Members

Commissariat à l'Énergie Atomique/Laboratoire National Henri Becquerel [LNE-LNHB], Gif-sur-Yvette.

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

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

Institute for Reference Materials and Measurements [IRMM], Geel.

Korean Research Institute of Standards and Science [KRISS], Daejon.

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

National Physical Laboratory [NPL], Teddington.

Physikalisch-Technische Bundesanstalt [PTB], Braunschweig.

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

Observers

Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas [CIEMAT], Madrid.

Chinese Institute of Atomic Energy [CIAE], Beijing.

International Atomic Energy Agency [IAEA].

International Commission on Radiation Units and Measurements [ICRU].

CONSULTATIVE COMMITTEE FOR IONIZING RADIATION

Report of the 21st meeting
(19 June 2009)

to the International Committee
for Weights and Measures

1 - 3 OPENING OF THE MEETING; WELCOME / AGENDA / APPOINTMENT OF A RAPPORTEUR

The 21st meeting of the Consultative Committee for Ionizing Radiation (CCRI) was held at the BIPM headquarters in Sèvres on 19 June 2009.

The following members were present: K. Carneiro (President), P. Sharpe (Chairman of CCRI(I)), B.R.S. Simpson (Chairman of CCRI(II)), D. Thomas (Chairman of CCRI(III)), A.J. Wallard (Director of the BIPM).

Guests attending were: A. Allisy, C. Borrás (IOMP), L. Erard (CIPM), L. Karam (NIST), G. Moscati, D. Müller, T.J. Quinn.

Participants from the BIPM were: P.J. Allisy-Roberts (Executive Secretary), D.T. Burns, C. Kessler, M. Kühne (Deputy Director of the BIPM), C. Michotte, L. Mussio, S. Picard, G. Ratel, C. Thomas.

The numbering below follows that of the agenda.

The President formally opened the meeting and welcomed all present. Dr Burns was appointed rapporteur and was thanked for producing the report of the previous meeting.

Dr Carneiro, President of the CCRI, invited Prof. Wallard, Director of the BIPM, to welcome the participants. Prof. Wallard thanked Dr Allisy-Roberts for implementing the celebration of the 50th anniversary of the CCRI, welcomed the invited guests and noted the delightful letters from those who were not able to attend, suggesting that these should be collected together. He thanked the guests for their individual and special contributions and hoped that their visit brought back pleasant memories as well as allowing them to see how things had progressed. Dr Carneiro noted the many guests who had been presented with certificates at the relevant Section meetings and presented a final certificate to Denise Müller for her extraordinary contribution over forty years to the work of the CCRI.

4 CCRI ACHIEVEMENTS

Dr Allisy-Roberts briefly presented some historical information on the establishment of the CCEMRI (the previous name of the CCRI), noting the presence of the first CCRI rapporteur (and subsequently first Head of Ionizing Radiation at the BIPM), Prof. Allisy, and his secretary, Mrs Müller. The reports of the three Section chairmen would show how things had progressed since that time.

5 REPORT OF THE 21ST CCRI MEETING OF THE 2007[**]

The President noted the report of the 20th meeting of the CCRI (2007) under the Presidency of Prof. Moscati, and had no comments to add.

6 SUMMARIES OF THE MEETINGS OF THE THREE CCRI SECTIONS

The President invited each Chairman in turn to report on the Section meetings held in April, May and June 2009.

6.1 CCRI Section I (Chairman P. Sharpe)

The Section I meeting was preceded by meetings of the Key Comparison Working Group (KCWG(I)) and the Accelerator Dosimetry Working Group (ADWG(I)) and by a Brachytherapy Workshop. The workshop highlighted both current practice and advances in the field, particularly the development of absorbed-dose standards for high dose rate (HDR) brachytherapy, involving both graphite and water calorimetry and a novel design of free-air chamber. The proposed HDR and LDR BIPM brachytherapy comparisons were discussed and a number of suggestions made for providing the necessary resources for these. Significant progress was made during a secondment to the BIPM (J. Alvarez, ININ, Mexico) and an appeal made for further help. Since the workshop, offers of secondments had been made by the DFM (for August) and the NMISA (for September). The first round of the HDR comparison can hopefully go ahead later in 2009.

Dr Burns had presented a draft paper on the *I*-value for graphite that will now be submitted for publication as well as to the ICRU Key Data Committee currently studying this issue. A possible consequence is a decrease of around 0.8 % for all air-kerma standards. A small task group was set up to look at a second possible correction (of up to 0.5 % at the lowest x-ray energies) that arises from an inconsistency in the fact that the realization of air kerma for photon beams makes use of *W*, which is defined for electrons.

Section I agreed to the changes in the BIPM air-kerma standards for low- and medium-energy x-rays and for ^{137}Cs radiation. These changes arise from a re-evaluation of correction factors and, in the case of the medium-energy free air chamber, from the identification of a long-standing problem with scattered radiation entering the chamber.

Of note among the reports of recent work at the BIPM is the graphite calorimeter absorbed-dose standard, which will be used for a series of bilateral comparisons in the high-energy x-ray beams of the NMIs. After testing at the LNE-LNHB earlier this year, comparison measurements have just been completed at the NRC. A second noteworthy item was the resolution of problems with

[**] Documents for the meeting which are openly available can be downloaded from the BIPM website.

the new standard for mammography and the first comparison planned for the end of 2009. Section I was very pleased with the progress made over the past two years and endorsed the work plan presented for the period 2009 to 2012. A project proposal for the subsequent period 2013 to 2016 was agreed in outline, although it was recognized that the details would depend on the outcome of the proposal to install an accelerator at the BIPM.

The CCRI(I) was encouraged by the CIPM support for the proposal for a BIPM accelerator, which is recognized within Section I as the best option to meet the needs of the BIPM Member States for accelerator comparisons and calibrations. In response to a request from the CIPM, Section I discussed the various options in detail and produced drafts of recommendations to the CIPM. Other material had also been prepared, including a letter to NMI Directors and an information leaflet. These were refined during the CCRI(I) meeting and are now submitted for discussion and approval by the CCRI.

Both the KCWG(I) and Section I had discussed options for incorporating the IAEA/WHO SSDL Network more formally into the CIPM MRA. The SSDL Network functions in a similar way to an RMO and Section I encouraged the BIPM and the JCRB to investigate ways in which the network could be given an equivalent status.

The special issue of *Metrologia* devoted to dosimetry was published earlier this year and thanks were expressed to everyone who contributed to its success.

An excellent seminar on "nano-dosimetry" was given by Hans Rabus of the PTB. This work represents a possible route to the definition of new quantities based on the biological effect of ionizing radiation and provoked a lively discussion.

Two applications for observer status, from the CIEMAT (Spain) and the ITN (Portugal), were discussed at Section I, with the recommendation that these be considered favourably by the CCRI. Presentations were also made by representatives of the NRPA (Norway), KRISS (Republic of Korea) and the NIS (Egypt), who might each apply for observer status in the future.

6.2 CCRI Section II (Chairman B.R.S. Simpson)

The Section II meeting was preceded by a number of working group meetings. The CCRI RMO Working Group on IR CMCs (RMOWG) clarified the rules to include the requirement for adding "approx. 95 %" for the level of confidence. The KCWG(II) discussed the generic measurement groupings table, particularly for the CIEMAT/NIST method, made changes to the degrees of difficulty, uncertainties and colour coding, and included additional radionuclides. The Uncertainties Working Group (UCWG(II)) proposed the use of *relative* sensitivity coefficients in the reporting form for comparisons. The working group on the realization of the bequerel (BqWG(II)) discussed difficulties with the initial prototype well-chamber requiring a new design; the instrument is now expected to be completed by 2012, in time for incorporation in the 2013–2016 BIPM programme. The working group on the extension of the SIR to pure β-emitters using liquid scintillation (ESWG(II)) highlighted stability problems; the solution is to send the sources to the BIPM, which will prepare the cocktail and measure using the CIEMAT/NIST and TDCR methods. The Working Group on High-efficiency photon detection systems (HEWG(II)) will produce a *Monographie*, the imminent retirement of Prof. Winkler allowing him to devote more time to this (perhaps on secondment to the BIPM).

The Section II meeting itself discussed changes to KCRVs arising from the inclusion of new submissions (for eight radionuclides) and the publication of ^{109}Cd and ^{123}I values including non-primary data. A notable problem was the ^{65}Zn submission of the BARC, which had a significant impact on the KCRV. This arises because the KCRV is currently an unweighted mean while the criterion for identifying an outlier includes the uncertainty. It was decided to undertake a feasibility exercise using weighted means for KCRV calculations.

A discussion of key comparisons noted the outcomes of the KCWG(II) given above. Of special note was the extension of the reporting deadlines for two current comparisons: ^{3}H (now 30 September 2009) and ^{177}Lu (now 31 July 2009). This was taken as an indication that NMIs might be experiencing some difficulty coping with their present workloads and supports the BIPM ten-year plan that includes just one K2 comparison each year.

The preliminary study using the travelling instrument (TI) with a ^{99}Tc^{m} solution from the LNE-LNHB showed great potential and excellent results were obtained at the NPL and NIST. A few difficulties were discussed, notably droplets remaining above the solution on the inner wall of the ampoule, and modifications to the protocol are under consideration with a different method of ampoule cleaning. Although currently limited to ^{99}Tc^{m}, the TI use might be expanded to other radionuclides which would require a change of liner. The next TI comparison visit is planned for 2010, with potential participants including the ANSTO, KRISS, LNMRI, NMIJ, NMISA, RC and the VNIIM.

Regarding supplementary comparisons of measurements in more complex matrices, three have been published since 2007 (seaweed, soil, IAEA natural materials mixture) and several more are close to publication. Additional matrices were proposed (microspheres, dried bilberries, rice) and an action was placed to determine accessibility for a variety of matrix materials. The need to register new comparisons in the KCDB was noted.

On the strategy for comparisons, results over thirty years old are to be removed from the KCDB, and the results pre-1984 are being phased out. The goal is to enforce a maximum of fifteen years for the validity of comparisons supporting CMCs. The current ten-year plan (from 2005) should be revisited in view of changing priorities and the changes made to the generic groupings. Notably, a number of comparisons outside this plan (^{177}Lu, ^{241}Pu and matrices) will have an impact on the work schedule.

Programme planning for the BIPM was discussed, including updates to the SIR (new ampoules, backup electronics, replacement of the Ge(Li) detector by the HPGe) and the extension to electron capture and pure beta emitters (being addressed by the ESWG(II)). The need for a strategic plan for Section II and perhaps a training working group was discussed. High priorities for the new developments within the 2013–2016 programme include extension of the travelling instrument to ^{18}F and other short-lived radionuclides, establishment of a new independent measurement method at the BIPM, construction of a becquerel chamber in collaboration with the IRMM, and the expansion of the SIR to alpha emitters and low levels of activity.

For the 50th anniversary of the CCRI, a seminar on fluctuations in long-term stability measurements of ionization chambers was given by Dr Heinrich Schrader.

6.3 CCRI Section III (Chairman D. Thomas)

The Section III meeting was held in April, with representatives from ten NMIs (including the IRMM), and an observer from the IAEA. The KRISS (Republic of Korea) participated as a full member for the first time, while unfortunately the NIM (China) was unable to attend.

In honour of the 50th anniversary of the CCRI, a special seminar on computational dosimetry was given by Gianfranco Gualdrini of the ENEA.

Four key comparisons were discussed. The comparison of monoenergetic neutron fluences (K10) is now published. The principal weakness in this comparison was the use of a single neutron field, that of the PTB. While this avoided the use of transfer instruments, it did not test the ability of participants to produce their own fields. The comparison of neutron source emission rate (K9) highlighted the difficulties in circulating a radioactive source. Two participants identified as outliers have discovered why this was the case and the Draft B report is now finalized. The comparison of thermal neutron standards (K8) is ongoing and is the first in this area. The longstanding and problematic comparison of monoenergetic (24 keV) neutron fields, undertaken between 1993 and 1998, has finally resulted in a Draft B report. This energy is considered a priority and a new key comparison is planned for October 2011 using the monoenergetic neutron facility AMANDE of the LNE-IRSN (Cadarache), for 24 keV and ISO recommended energies.

Regarding RMO and supplementary comparisons, the EURAMET comparison of survey instruments was interrupted by instrument failure. The data accumulated to date will nevertheless be used and the comparison will continue with a new instrument, with at least one participant repeating as a cross reference. The EURAMET comparison of neutron fluence in the range 15 MeV to 19 MeV (three participants) is essentially complete, with the Draft B report to be approved by the EURAMET. A EURAMET comparison of long counters measuring fluence is under way and a further project is planned to re-evaluate the radionuclide spectra of the sources recommended by the ISO as standards. A supplementary comparison of personal dosemeters was proposed, which the LNMRI/IRD (Brazil) was asked to pilot with the help of the BIPM, although this has not yet been confirmed.

The NMIs having CMCs but not attending Section III meetings were discussed, notably the NMIs of Australia, Canada, Italy and Slovakia. It was suggested that they, as well as the BARC (India), be invited as guests to the next meeting. The ENEA-INMRI (Italy) was cited as an example of an NMI with CMCs that does not participate in the relevant CCRI comparisons, notably those for manganese bath measurements and thermal neutron calibrations. The pilot of the current comparison of thermal field measurements was asked to inform the ENEA-INMRI of this exercise. The suggestion was made (by Dr M. Kralik) that RMO working groups might not have the technical expertise required to assess certain neutron CMCs and it was proposed to hold a one-day meeting on neutron CMCs just before the next Section III meeting.

The *Metrologia* special issue on neutron metrology was discussed; ten papers, each of around sixteen pages, are proposed and the corresponding lead and assisting authors have been identified. First drafts have been requested by the end of 2009, for final publication in 2010. There was a call for more non-US and non-European authors. The view was expressed that neutron expertise is disappearing and might be bolstered by a neutron workshop in the 2009 to 2012 period, perhaps linked with the special issue in collaboration with the IAEA or IRMM to widen the invitation list.

The CCRI President encouraged discussion of the strategy for neutron metrology, anticipating user needs of the future. Over the past twenty years most of the work has been related to radiation protection, with a brief diversion into neutron radiotherapy although this form of cancer treatment has not flourished. Much work in the protection area remains, as no device has yet been developed that measures the desired quantity to the required accuracy. New areas include stray neutron fields around therapy linacs, PET machines, light ion therapy accelerators and synchrotron light sources. The most obvious future need is standards for fusion, but other areas include high-energy fields for radiation hardness testing, measurements around pulsed, laser-based accelerators and the European Spallation Source to be built in Norway. Dr Borrás mentioned the increasing use of neutrons in security screening. This poses a special comparison challenge to the CCRI, since many such systems use pulsed beams of fast neutrons.

7 DISCUSSION ON STRATEGY FOR IONIZING RADIATION METROLOGY

7.1 Strategy for an accelerator at the BIPM

Dr Allisy-Roberts presented document CCRI/09-01, an update on progress towards an accelerator at the BIPM following the second meeting of the ADWG(I) in May 2009. After trial measurements at the LNE-LNHB and the formulation of a comparison protocol, the first full bilateral comparison had just been completed at the NRC and the preliminary results were satisfying. Dr Allisy-Roberts noted that, in addition to the original eight participating NMIs, a further two, VNIIFTRI and NMIJ, might also wish to participate. A draft letter soliciting the support of the Directors of the NMIs and other Designated Institutes had been discussed and modified and would be finalized in the form of a short paper for the meeting of NMI Directors in October 2009. Two draft recommendations to the CIPM were prepared by the ADWG(I) and Section I as precursors to two resolutions of the CGPM on the installation of an accelerator at the BIPM and on the funding for this project as an “exceptional dotation”. French translations had been made in preparation for the CIPM. After discussion of the various options, these recommendations consider comparisons and calibrations only using a reference facility at the BIPM. A building plan had been drawn up and the accelerator specification was in progress. A draft mini-brochure, proposed by the ADWG(I) in 2008, had been prepared by the BIPM and modified by the CIPM in 2008 and by the ADWG(I) and Section I in 2009 to emphasize the benefits to those BIPM Member States not having primary accelerator standards. French and Spanish translations had been prepared. The generous offer made by Mr Erard of five weeks per year on the new LNE-LNHB metrological accelerator was considered by the ADWG(I) of Section I not to be a solution that would meet the needs of Member States.

Dr Carneiro invited comments from the participants. Dr Borrás wished to record formally that the IOMP was in full support of the proposal for an international reference accelerator at the BIPM (as had been stated by H. Svensson in 2007). She also suggested that the leaflet should emphasize that traceability is obligatory and that the relevant international (written) standard be explicitly referenced.

Dr Sharpe restated the Section I view that a BIPM accelerator was the best option for Member States, building on BIPM expertise and track record. He noted that in order to keep pace with

changes in radiotherapy an accelerator at the BIPM was a natural progression towards the goal of achieving worldwide traceability, and while recognizing the generous offer of Mr Erard, he emphasized that it was not a practical solution. Dr Borrás advised the purchase of an accelerator that would allow research into new dosimetry techniques, for example small-field dosimetry. This view was seconded by Dr Sharpe, who added that the accelerator must be clinically representative.

Prof. Wallard stressed that this was a matter of top priority and that it was essential to rally the support of government delegations at the earliest opportunity; in this he encouraged the participants at the meeting to impress on their respective government officials that the scientific and logical case is without question. The project must not fail through a failure to lobby government representatives sufficiently; failure in 2011 would have detrimental consequences. Prof. Kühne voiced his full support and would do his best as the new BIPM Director when presenting the proposal to the CGPM.

Mr Erard found himself in a difficult situation. On the one hand, as a member of the CIPM, he could approve the proposal if the argument was better made; by this, he felt that non-scientists were not particularly responsive to arguments on traceability and needed to be told more directly the magnitude and the consequences of dosimetric errors. On the other hand, as a French Government representative, he stated that the proposal was not acceptable as a "special contribution", but that it might succeed if included in the BIPM dotation. Prof. Kühne identified the problem in two distinct stages; first, to convince the Member States of the need and, second, to find the best way to finance it. One possibility, for example, was to include the accelerator itself in the BIPM budget, but to fund the building from the BIPM reserves.

Dr Carneiro offered a counter-argument, stating that if 60 % of the world's accelerators were in the eight countries with primary accelerator standards, the problem was already solved for the majority. Dr Allisy-Roberts countered that it was a question of patient safety – errors due to indirect calibrations are unacceptable and everyone should have an equal opportunity with respect to the safety of radiotherapy treatment. Prof. Moscati noted that even for these eight NMIs it was only through comparisons that one could be confident that significant discrepancies did not exist. This was seconded by Dr Sharpe, who pointed out that NMIs do not work in isolation, citing the case of ^{60}Co comparisons as an example. Prof. Kühne argued that this was exactly the type of task for which the BIPM was created, facilitating the verification of national standards at every level.

Dr Quinn saw two types of argument, the first that the BIPM is the best place for this activity and the second regarding patient health. He cautioned against the use of figures relating to errors and deaths on the basis that such statistics are always open to contention. He summarized that clearly the issue is money, and Dr Allisy-Roberts confirmed that the CIPM had openly stated this.

The President suggested that the BIPM Director now had sufficient material and moved to a formal approval. **The proposal for an electron accelerator at the BIPM was unanimously endorsed**.

7.2 General Strategy

Dr Carneiro made a short presentation of the paper CCRI/09-02, which is a draft proposal for a CCRI Strategy document. The proposal comprises five sections: (i) Mission and Tasks, which

sets out the role of the CCRI and makes use of information available on the BIPM website; (ii) Stakeholders, which lists institutions with an interest in the work of the CCRI (IAEA, ICRU, IOMP, NMIs, etc.) and end-users (calibration laboratories, health authorities, etc.); (iii) Vision/Strategy, which sets out the response to the needs of BIPM Member States; (iv) Actions, which is divided into short-term (one to two years and ongoing activities), medium-term (three to eight years, i.e. the next CGPM budget) and long-term (nine to fifteen years); (v) SWOT analysis (Strengths, Weaknesses, Opportunities and Threats).

A number of specific suggestions were made regarding the inclusion of particular bodies, sectors and research areas. Prof. Wallard suggested that the approach that Dr Carneiro had developed would help the CCRI to formulate its future programme and Prof. Kühne added that it should also help convince the CIPM. Dr Carneiro noted the timescale to present the document to the CIPM in October 2009. Dr Quinn suggested the document should be kept short, to which Dr Carneiro suggested that more expansive information would be put into annexes.

8 ISSUES OF COMMON INTEREST

In view of the limited time available, the nine issues listed in the agenda were dealt with rapidly.

8.1 CIPM MRA and related matters

No further issues raised.

8.2 Document on validity of comparisons

Would be amended following the comments of the CCRI RMOWG and circulated through each of the Sections.

8.3 Working Group remits and membership

Most had been received and were available in the Section working documents. The President would have these for presentation to the CIPM.

8.4 *Metrologia* special issues

Dosimetry and Radionuclide Activity issues published, Neutron issue in progress, as discussed.

8.5 Future BIPM programme

The proposed future BIPM programme for 2013 to 2016 was endorsed.

8.6 Future CCRI programme

The strategy paper would be reviewed by the President and the three Section Chairmen.

8.7 CCRI Membership

Dr Allisy-Roberts welcomed the presence of an IOMP representative and while both ICRU and IAEA representatives had also been invited, the notice had been too short for them to attend. **There was unanimous support for inviting observers from international organizations to future CCRI meetings**.

8.8 Chairmen and Section membership

Section I supported the requests by the CIEMAT (Spain) and the ITN (Portugal) to be observers. **The CCRI endorsed these requests and proposed that the President submit them to the CIPM for approval.**

8.9 Recommendations to the CIPM

The recommendation for an electron accelerator at the BIPM had already been endorsed. Dr Sharpe recalled the discussion on the possible inclusion of the IAEA/WHO SSDL Network in the CIPM MRA and said he would work with Dr Allisy-Roberts to find an appropriate wording for the BIPM KCDB. Regarding the forthcoming ^{241}Pu comparison, the BIPM Director would invite the IAEA Director to sign a joint letter to assist with customs and security arrangements. The request for BIPM assistance in the Section III supplementary comparison on personal dosimeters was noted. **All the above points were formally endorsed by the CCRI**.

9 DATES FOR NEXT CCRI MEETINGS

In view of the need to finalize the accelerator proposal, as well as the Strategy document, before the CIPM meeting in October 2010, Dr Carneiro suggested that meetings of the CCRI and the ADWG(I) would be required in early 2010. No dates were fixed for these meetings; progress would be assessed at the time of the CIPM meeting in October 2009. Dr Allisy-Roberts remarked that May 2010 might tie in well with the next RMO Working Group.

10 CONCLUDING REMARKS

No other business was raised and the President thanked the participants and closed the meeting.

APPENDIX R1.
Working documents submitted to the CCRI for its 21st meeting

Documents restricted to Committee members can be accessed on the restricted website.

Document CCRI/	
09-00	Draft agenda, 1 p.
09-01	BIPM. — Accelerator dosimetry update, P.J. Allisy-Roberts, 1 p.
09-02	DFM (Denmark). — Strategy paper for the CCRI, K. Carneiro, 4 pp.

CONSULTATIVE COMMITTEE
FOR IONIZING RADIATION

Section I: x- and γ-rays, charged particles
Report of the 19th meeting
(13-15 May 2009)

Abstract

Section I (x- and γ-rays, charged particles) of the Consultative Committee for Ionizing Radiation (CCRI) held its 19th meeting at the BIPM headquarters, Sèvres, from 13-15 May 2009. As 2009 marked the 50th anniversary of the founding of the CCRI, a number of guests were invited to attend the first day of the meeting. The President of the CCRI presented each with a certificate acknowledging their important contributions to the work of the Section. The CCRI(I) meeting was preceded by meetings of the key comparison working group and the accelerator dosimetry working group on 11 May 2009 and by a workshop on brachytherapy dosimetry on 12 May 2009. Recommendations and feedback from the working group meetings and the workshop provided important input to the CCRI(I) meeting. Dr Hans Rabus of the PTB gave an invited lecture on nanodosimetry and described how concepts now being tested may affect future radiation quantities. The meeting endorsed the BIPM recommendations to adjust its standards for low-energy and medium-energy x-rays to account for new understanding of aperture effects and its air-kerma standard for ^{137}Cs γ-rays to account for improved estimations of correction factors. An examination by BIPM staff of the consistency of the recommended values for *W/e* and the graphite stopping power suggested that air kerma standards based on cavity chambers may need to be revised. The proposal to establish an accelerator laboratory at the BIPM continues to receive support from the international community and the CCRI(I) endorsed a recommendation by the CCRI to the CIPM that would request the necessary dotation to fund the project. Applications for membership were reviewed from two national metrology institutes.

1 OPENING OF THE MEETING; APPOINTMENT OF A RAPPORTEUR

Section I (x- and γ-rays, charged particles) of the Consultative Committee for Ionizing Radiation (CCRI) held its 19th meeting at the BIPM headquarters, Sèvres, from 13-15 May 2009.

The following Members and representatives were present:

J.M. Bordy (LNE-LNHB), K. Carneiro (President of the CCRI), I. Csete (MKEH), F. Delaunay (LNE-LNHB), S. Duane (NPL), H.-M. Kramer (PTB), F.J. Maringer (BEV), M. Mitch (NIST), C. Oliver (ARPANSA), M. Pimpinella (ENEA-INMRI), C. Ross (NRC-INMS), S.M. Seltzer (NIST), P. Sharpe (NPL, Chairman of CCRI Section I), A. Steurer (BEV), M.P. Toni (ENEA-INMRI), D. Twerenbold (METAS), E. van Dijk (VSL), Anna Y. Villevalde (VNIIM), D. Webb (ARPANSA), Zhang Yanli (NIM).

Observers:

A. Meghzifene (IAEA), Z. Msimang (NMISA), J.G. Peixoto (LNMRI/IRD), V. Sochor (CMI).

Guests:

T. Aalbers (c/o VSL), H. Bjerke (NRPA), A. Brosed (c/o CIEMAT), G.M Hassan (NIS), R. F. Laitano (ENEA-INMRI), C. Oliveira (ITN), H. Rabus (PTB), C.Y. Yi (KRISS), A. Allisy (c/o BIPM), J.T. Álvarez Romero (ININ), J. M. Los Arcos (CIEMAT).

BIPM members also present for all or part of the meeting: A.J. Wallard (Director), P.J. Allisy-Roberts (Executive Secretary of the CCRI), D.T. Burns, L. Erard (CIPM & LNE), C. Kessler, M. Kühne (Deputy Director), L. Mussio (JCRB Executive Secretary), S. Picard, G. Ratel, P. Roger, C. Thomas (KCDB coordinator).

Apologies were received from:

D. Butler (ARPANSA), J. Kokocinski (GUM), N. Saito (NMIJ/AIST).

The meeting was called to order at 10 am on 13 May 2009 by the Chairman, Dr Sharpe.

Dr Wallard, Director of the BIPM, welcomed the delegates to the BIPM and to the 19th meeting of the CCRI(I). He pointed out that this would be the last CCRI(I) meeting that he would attend as Director because he retires at the end of 2010. He then introduced Dr Michael Kühne who will assume the position of Director upon Dr Wallard's retirement.

Dr Kühne reviewed his background, first at the BESSY storage ring and then at the PTB. His scientific background is in UV radiometry and thermometry. He served in various roles with EUROMET and became the first chairperson of EURAMET. He assumed the role of Deputy Director of the BIPM on 1 April 2009.

Dr Carneiro, the President of the CCRI, joined the meeting about mid-morning as his flight had been delayed. Because it was his first CCRI(I) meeting, he spent some time describing his background. His scientific expertise is in materials science, and he was responsible for founding the Danish metrology institute. He is a member of the CIPM member.

His duty as CCRI President is to represent the interests of the CCRI at meetings of the CIPM. His role is complicated because of the diverse interests of the three sections of the CCRI.

Dr Carneiro noted that the BIPM maintains a large effort in the CCRI field, and he recognized the important role that Dr Allisy-Roberts plays in coordinating the work of the three sections.

The delegates introduced themselves.

Dr Ross was appointed as rapporteur.

Before beginning the formal agenda, Dr Allisy-Roberts briefly reviewed the history of the CCRI and presented some photographs from early meetings. Originally referred to as the CCEMRI, the first meeting was held from the 13 to 15 April in 1959. The chairperson for the meeting was Dr Astin from the NBS (now the NIST) with Professor André Allisy (later at the BIPM) as rapporteur. It was agreed that there should be three subcommittees reflecting the different areas of expertise. Several years later, a fourth committee dealing with alpha particles was added. A key recommendation was that the BIPM should establish scientific programs in radioactivity and ionizing radiation dosimetry. The first meeting of CCEMRI Section I for x-ray and gamma-ray dosimetry was held in 1970 under the Chairmanship of Dr W.A. Jennings of the NPL. The CCEMRI was renamed as the CCRI in 1997.

2 CHANGES OR ADDITIONS TO THE AGENDA

The Chairman noted that several papers had been submitted after the deadline. He emphasized the importance of having papers submitted in time for review before the meeting.

The Chairman proposed that agenda items 6 (CCRI Strategic planning) and aspects of 8.1 concerned with the installation of an accelerator at the BIPM could best be discussed in conjunction with item 10 (BIPM Programme).

Otherwise, the agenda (CCRI(I)/09-00) was adopted without further change.

3 REPORT OF THE PRESIDENT AND THE CCRI, MAY 2007

The name change for the CCRI(I), from x and γ rays, electrons to x and γ rays, charged particles, was approved by the CCRI in May 2007 and accepted by the CIPM in October 2007.

The CCRI had endorsed the BIPM proposal to establish an international accelerator facility at the BIPM.

The Chairman thanked the rapporteur (Dr Ross) for the minutes of the 18th meeting of the CCRI(I).

4 CCRI STRATEGIC PLANNING

It was agreed that this agenda item would be discussed under item 10.

5 CURRENT ISSUES IN DOSIMETRY

5.1 Physical constants – W/e and stopping powers

Mr Seltzer discussed the work of the ICRU report committee on key data. He indicated that it was progressing slowly but the committee was to meet in Barcelona in the fall of 2009. Mr Seltzer stressed the importance of recent work by Dr Burns (CCRI(I)/09-32) studying the consistency of the recommended values of *W/e* and the graphite stopping power. A copy of this paper has been sent to the chairperson of the report committee.

Dr Sharpe encouraged the ICRU to continue its work and asked Dr Burns to present the key results from his paper, CCRI(I)/09-32.

Dr Burns reviewed recent measurements and calculations. His analysis suggests that an *I*-value for graphite of about 82 eV best fits all available data and leaves the value of *W* unchanged at 33.97 eV per ion pair. Mr Seltzer commented that this value is consistent with what he gets by appropriately averaging measured *I*-values. Dr Burns pointed out that one consequence of this analysis is that the value of air kerma deduced from cavity chamber measurements would change by about 0.8 %.

5.2 Changes to the BIPM standards

Dr Burns summarized changes to the BIPM free-air standards as a result of the evaluation of aperture effects. A paper has been published (*Phys. Med. Biol.* **54** (2009) 2737-2745) describing the changes. The rather large effect (up to 0.7 %) of the holder supporting the aperture in medium-energy x rays explains discrepancies noted in earlier comparisons. The BIPM suggested that the changes to their standards be introduced on 1 September 2009.

The Chairman proposed a formal recommendation that the BIPM change its medium energy x-ray standard and low-energy x-ray standard on 1 September 2009, and the recommendation was endorsed by the CCRI(I) membership.

With regard to low-energy x-ray comparisons, Mr Seltzer asked why a beam quality at 10 kV is supported, given the difficulty of making accurate measurements at this energy. Dr Carneiro suggested, in general, that one should not support standards for which there is no longer a need. However, some members felt that the 10 kV point plays a useful role, particularly for radiation protection purposes.

Ms Kessler then presented the rationale for changes to the BIPM standard for ^{137}Cs air kerma. Details are given in CCRI(I)/09-36, but the changes arise from re-evaluations of the wall

correction, the axial non-uniformity correction, the chamber volume and the saturation correction. The overall change is an increase in the measured air kerma of 0.3 %.

The Chairman proposed a formal recommendation that the BIPM change its standard for ^{137}Cs air kerma on 1 September 2009, and the recommendation was endorsed by the CCRI(I) membership.

5.3 Cavity volumes

Dr Delaunay summarized report CCRI(I)/09-19 which describes new cavity air-kerma standards at the LNE-LNHB. Instead of relying on one chamber they now have six, all differing in either size or shape. The chamber volumes were determined by filling the cavities with water and weighing. The wall correction factors were determined using both the EGSnrc and PENELOPE Monte Carlo codes, and were checked using measurements with added caps. The maximum difference observed when measuring ^{60}Co air kerma with the six chambers was 0.25 %.This is considerably larger than would be expected based on the uncertainty estimates and may suggest that the volume uncertainty has been underestimated.

6 FEEDBACK FROM WORKING GROUPS

6.1 Accelerator Dosimetry Working Group

Dr Sharpe summarized the purpose of this working group. Ideally, the BIPM would have a clinical accelerator that would permit it to participate in the dosimetry of high-energy x-ray and electron beams. However, the mandate of the working group is to consider more broadly the role of the BIPM in high-energy clinical dosimetry, either with or without an accelerator. Dr Sharpe felt the discussion could be divided broadly into two parts, the first having to do with the BIPM calorimeter and the second with the proposal related to establishing an accelerator laboratory at the BIPM. He proposed to discuss the first part under this agenda item, but to defer the second part to agenda item 10.

Dr Allisy-Roberts reviewed the ADWG report from April 2008. Three options had been considered, and the option for the BIPM to transport its calorimeter to several NMIs had been accepted. Dr Picard summarized the protocol, which is described in more detail under BIPM.RI(I)-K6. The proposed schedule of laboratory visits was reviewed. The first formal comparison will be with the NRC in June 2009.

Dr Allisy-Roberts thanked the LNE-LNHB for their help in testing the calorimeter in their laboratory.

6.2 Brachytherapy Working Group – Workshop report

The brachytherapy workshop was held on 12 May 2009. With 11 presentations on a wide range of subjects and an attendance of 27, it was considered very successful. Several laboratories,

particularly the ENEA, PTB and the NPL are active in establishing D_w for ^{192}Ir HDR sources while the ENEA reported also for LDR sources. The LNE-LNHB and the NIST discussed their preliminary results in characterizing ^{125}I sources in terms of reference air kerma.

Dr Allisy-Roberts reviewed the status of the two comparisons that the BIPM is committed to carrying out. Dr Álvarez-Romero worked on secondment with the BIPM for four months in 2008 and established the protocol for the HDR ^{192}Ir comparison and a draft protocol for the LDR ^{125}I comparison. However, delivery of the ^{137}Cs test source was delayed, so it was not possible to carry out the comparison during the time Dr Álvarez-Romero was at the BIPM.

For the HDR comparison, an NE2571 chamber will be calibrated by each NMI, as well as a well-type chamber. The BIPM will supply both instruments, and it was agreed that they should be hand-carried to each laboratory.

In the case of the LDR comparison, seeds will be sent to each of the participants. They will measure the seed air-kerma strength and report the result to the BIPM.

There was some discussion regarding a suitable source to use for checking stability of the BIPM well chamber, and there was a general consensus that ^{241}Am was probably the best choice.

Both METAS and MKEH expressed an interest in participating in the comparisons.

Dr Allisy-Roberts emphasized the need for extra help in carrying out the HDR and LDR comparisons and called on NMIs to identify possible candidates.

6.3 Key Comparisons Working Group

There have been two meetings of the Key Comparisons Working Group (KCWG) since the last CCRI(I) meeting. Dr Allisy-Roberts reviewed the action items arising from the meeting in April 2008 as summarized in CCRI(I)/09-1. Item 5 recommended that the CCRI remove comparison BIPM.RI(I)-S11 from the KCDB. This comparison is for absorbed dose to graphite, and it was assumed that it was no longer relevant because absorbed dose to water is the quantity of interest.

Dr Carneiro asked if any CMCs depended on this comparison for their traceability, and a check by Dr Thomas indicated that there are eight CMCs that depend on D_g. This discovery led to considerable debate as NMI delegates assessed their relevant CMCs. After review, all NMIs present agreed that they did not have any CMCs that needed to be based on the absorbed dose to graphite comparison. The NMI of Russia, the VNIIFTRI, needs to be contacted to determine the status of their CMCs that are tied to D_g.

The delegates recommended that BIPM.RI(I)-S11 be removed from the list of current comparisons in Appendix B and a letter be sent to all relevant NMIs informing them of the decision.

Dr Allisy-Roberts reviewed the appropriate terminology for describing degrees of equivalence with respect to key comparison reference values. The wording will be made available in the RMO terminology document and is published in the article by Allisy-Roberts *et al.* in the recent issue of *Metrologia* (**46**, 2009, S1-S8) dealing with radiation dosimetry.

Item 9 of CCRI(I)/09-1 proposed a working group to consider establishing a generic set of x-ray beam qualities to be used for comparisons. It was agreed that Dr Csete would consider the issue

and it would be reviewed at the next meeting of the KCWG, which might be held in conjunction with the IAEA conference in November 2010.

The most recent meeting of the KCWG was held on 11 May 2009, and Dr Kramer's notes from that meeting were handed out for consideration. The meeting had established six recommendations and the discussions surrounding each are summarized below.

1) It was agreed that that NMIs should assist the BIPM in preparing the first draft of comparison reports so as to ease the work load on the BIPM staff.

2) This recommendation dealt with the possibility of recognizing the SSDL network of the IAEA as a new RMO so that comparisons involving the SSDLs could be registered in the KCDB. Dr Mussio raised concerns as to whether or not all laboratories who are members of the SSDL would meet the requirements for membership in an RMO. Dr Carneiro saw it as a way of enhancing the links between the IAEA and the CIPM. The meeting agreed to change the wording of the recommendation to remove mention of an RMO and instead to encourage the IAEA and the BIPM to explore ways to have IAEA/SSDL comparisons registered in the KCDB.

3), 4), 5) It was agreed that these recommendations concerning changes to the BIPM x-ray standards, the EUROMET K1 and K4 comparisons and the BIPM Cs-137 standards, would be discussed elsewhere in the meeting.

6) This recommendation dealt with the fact that the CMCs for ionizing radiation give the confidence level as "unspecified" whereas the CMCs for all other areas of activity give it as 95 %. It was agreed that the CCRI(I) recommend that the RMO working group consider the issue with a view to modifying the CMCs of the CCRI accordingly.

7 COMPARISONS OF DOSIMETRY STANDARDS (x- AND γ-RAYS, CHARGED PARTICLES)

7.1 BIPM and CCRI key comparison status

7.1.1 BIPM.RI(I)-K1, BIPM.RI(I)-K2, BIPM.RI(I)-K3, BIPM.RI(I)-K4, BIPM.RI(I)-K5, BIPM.RI(I)-K6, BIPM.RI(I)-K7 (proposed)

Dr Allisy-Roberts summarized the status of the key comparisons identified as BIPM.RI(I)-K1 through K6. In response to a question regarding the uncertainty shown for the ININ in the linked comparison SIM.RI(I)-K4, Dr Álvarez-Romero stated that the laboratory had mistakenly used an expanded uncertainty for the calibration coefficient of their reference standard in their uncertainty budget shown in Table 4 of the final report of the comparison. Correcting for this error would reduce the overall standard uncertainty reported as 1.18 % to 0.63 %.

As the BIPM standard for ^{137}Cs air kerma is proposed to be changed, the results of previous ^{137}Cs comparisons to be published in the KCDB under BIPM.RI(I)-K5 will also change.

BIPM.RI(I)-K7 is a proposed comparison for mammography x-ray qualities. Ms Kessler presented her results obtained using a new free-air chamber (CCRI(I)/09-37). Discrepancies of up to 0.8 % have been observed between the new chamber and the existing standard for low-

energy x-rays. Improved alignment between the guard and collector has reduced the discrepancy, and further investigations are in hand.

A new x-ray tube with a Mo target has been installed and commissioned. Dr Kramer asked about the choice of 60 µm for the Mo filter and suggested that 35 µm may be more appropriate. Ms Kessler pointed out that the 60 µm filter was what she had been using with the W tube. Dr Meghzifene suggested that 28 kV should be considered for comparisons, and delegates thought that 20, 28 and 35 kV would be a suitable choice. A calibration distance of 50 cm was proposed, although NMIJ had suggested 80 cm in previous discussions (the delegate from NMIJ was unable to attend the meeting). The distances of 60 cm at the BEV and 100 cm at the PTB were noted. The final conditions would be decided by the near-future participants.

7.1.2 CCRI(I)-K4, K6

CCRI(I)-K6 was to be a comparison of high-energy x-ray beams using transfer chambers. It was decided to abandon this comparison, partly because no progress had been made, but also because the new program of comparisons with the BIPM calorimeter will directly compare primary standards for MV x-rays.

One of the chambers involved in CCRI(I)-K4 has been broken and another on loan has been returned; in any case, the EUROMET comparison EUROMET.RI(I)-K4 supersedes this comparison. It was recommended that the participants be notified that the comparison has been abandoned.

7.1.3 CCRI(I)-S2

CCRI(I)-S2 is a high-dose comparison using alanine. The results have all been submitted. Dr Carneiro pointed out that the Risø high dose laboratory had now been formally designated as the Danish national laboratory for high-dose measurements and, it participated in the comparison.

7.2 Comparison reports for approval

A draft report of a comparison of absorbed dose to water for ^{60}Co between the VSL and the BIPM is circulating for approval. The delegates of CCRI(I) serve as referees of these reports and the process is working well.

An article by Allisy-Roberts *et al* in the recent issue of *Metrologia* (**46**, 2009, S1-S8) can be consulted for appropriate terminology to use when describing the KCRV in comparison reports.

7.3 Regional key and supplementary comparisons

7.3.1 EURAMET.RI(I)-K1

This comparison was of air-kerma standards for ^{60}Co and involved 26 participants. Four chambers and two electrometers were supplied by MKEH, which acted as the pilot laboratory. Dr Csete pointed out that 7 of the 9 results supplied by PSDLs were used to link the results to

the BIPM. Dr Sharpe formally thanked Dr Csete for the massive effort required to successfully complete such a large comparison.

Dr Hassan asked if his laboratory, which is an SSDL, could have participated. He was assured that he could have participated but because it is too late now to become involved he may want to consider carrying out a bilateral comparison.

Dr Allisy-Roberts pointed out that it is important that uncertainty budgets be attached to the final report. Dr Csete indicated that there seemed to be some anomalies in the uncertainty reports, but it is too late to change them now.

7.3.2 EURAMET.RI(I)-K4

This comparison was of standards for absorbed dose to water and was carried out at the same time as EURAMET.RI(I)-K1. A single report is being prepared on both comparisons so both were discussed under 9.3.1.

7.4 Calibration of transfer standards

7.4.1 Field-size effects in low-energy x-ray beams

Dr Burns pointed out that the effect on the calibration coefficient of changing the field size can be quite different, depending on the type of chamber. For a common PTW chamber, the field-size effect for the CCRI 50 kV(a) quality is about 1 %, while for the Radcal model the effect is much smaller. He also pointed out that, independently of this effect, the calibration coefficient may differ by up to 0.5 % depending on whether the chamber is calibrated at a distance of 0.5 m or 1 m from the source.

8 CURRENT AND FUTURE PROGRAMS AT THE BIPM

This agenda item, which incorporated item 6 (CCRI strategic planning) began with a presentation by Dr Carneiro on strategic planning. In general, he felt the BIPM needed to be more ambitious in its plans for the future. He emphasized the importance of having a long-term view, perhaps in the range of 10 to 15 years, and from this perspective one should be able to choose future options for the BIPM. One needs to construct a prioritized wish list with good cost estimates and ideas on how to obtain funding. He pointed out that a standard SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) can be a useful technique for an organization to use for planning purposes.

In terms of the CCRI, it must report to the CIPM meeting in October 2009, so a draft of the strategic plan should be available in June.

Dr Wallard summarized the outcome from the last meeting of the CGPM in November 2007. There were no recommendations for specific cuts, but there was not enough money available to cover all initiatives, so savings of 4 M€ had to found.

The CGPM meets on a four-year cycle with the next meeting scheduled for 2011. The CIPM meets annually and will produce a proposed budget in October 2010 for consideration by the CGPM. Workshops on nanometrology and bioscience will be held in early 2010 to help establish strategic directions.

The CCRI has an opportunity to make recommendations to the CIPM for its meeting in October 2009, and this should include the case for a clinical linac at the BIPM. Dr Allisy-Roberts circulated a draft of a recommendation to be submitted to the CIPM regarding a linac.

Dr Allisy-Roberts summarized progress by the Ionizing Radiation Section at the BIPM since the last CCRI(I) meeting. Work included: a change to the ^{60}Co air-kerma standard; introduction of the new Co source for comparisons and the calibration service; the construction of new cavity chambers; a study of the aperture effect for free-air chambers; significant progress with the calorimetry project; and significant work on x-ray standards for mammography.

Dr Sharpe acknowledged the success of the BIPM in achieving the objectives endorsed by the CCRI(I).

Dr Picard gave a presentation on the graphite calorimetry project. She described the key features of the graphite calorimeter and outlined the steps needed to establish the absorbed dose to water. She discussed the protocol (BIPM.RI(I)-K6) that will be followed in taking the calorimeter to various NMIs. Preliminary tests of the calorimeter in the linac beam at the LNE-LNHB had been successful.

Dr Allisy-Roberts discussed the expected work load for the period 2009-2012. The number of calibrations and comparisons for each standard can be predicted with reasonable certainty. A source replacement for the ^{60}Co unit is planned for 2011. Seven MV x-ray comparisons are planned with the graphite calorimeter over the next four years, and a tentative schedule was presented.

Dr Allisy-Roberts indicated that an offer of suitable manpower to help with the brachytherapy comparison may be forthcoming. If so, she would aim to complete the HDR comparison in 2009 and the LDR comparison in 2010.

Dr Allisy-Roberts indicated that the BIPM used to have a program in thermometry but it has been terminated. The Ionizing Radiation Section has agreed to take on the duty of continuing the temperature calibration service to support their work in calorimetry.

Dr Allisy-Roberts described the BIPM planning process for the work term 2013-16. The CCRI(I) makes recommendations to the CCRI which reports to the CIPM in October 2009. The CIPM then prepares resolutions for the 24th meeting of the CGPM in 2011. She pointed out that the core activities of the Ionizing Radiation Section would remain the same. Three new developments are proposed: a BIPM clinical accelerator; the establishment of some capability for electron dosimetry; and a new source for the radiation protection quantities.

There was some discussion as to the need for electron beam dosimetry, with some laboratories reporting decreased client demand while others felt demand was steady or even increasing.

There was agreement that the clinical accelerator should remain top priority. In terms of other possible work items, Dr Kramer indicated that there is a lot of interest in non-reference dosimetry while Mr Seltzer considered small-field dosimetry to be a priority and was supported by Dr Aalbers.

Discussion returned to the material regarding the BIPM accelerator proposal, including the recommendations to the CIPM and the leaflet outlining the rationale for establishing a clinical linac at the BIPM. Members discussed, and agreed to, various wording changes for the recommendations, but were generally supportive of the document. Dr Allisy-Roberts asked that members return their comments on the leaflet within one month.

A letter is being prepared to be sent to all NMIs with no accelerator to describe the background of the BIPM accelerator proposal and to propose two options. One option, resulting from an offer made previously by Dr Erard, could be for the BIPM to have access to about 10 % of the time on an accelerator located at the LNE-LNHB. Drs Erard and Delaunay described the background of the offer by French government officials. The plan is to establish a second linac at the LNE-LNHB and under these circumstances Dr Delaunay saw no problem with providing 10 % of the time to the BIPM. However, he drew attention to the fact that support for the present machine will terminate in 2011, and with only one linac it will be considerably more difficult to provide access. There was also a concern expressed by members that 10 % of the time per year would not permit the BIPM to establish a meaningful dosimetry program.

Members agreed that the letter should be sent to the NMIs, but only after the BIPM has a final decision from the LNE Director. The letter would first be sent to the head of each NMI, but if there is no response in a reasonable time, a copy of the letter will be sent to a member of the laboratory staff.

9 DEVELOPMENT OF NATIONAL STANDARDS FOR PHOTON DOSIMETRY

Several members gave brief presentations on work in their laboratories related to photon dosimetry.

Dr Kramer summarized the status of the new PTB accelerators. The research linac is now operating and can provide beams from 300 keV to 50 MeV. He showed measured k_Q data for several chambers of the same type. These data indicate that there is little chamber-to-chamber variation. The PTB has been able to use water calorimetry to establish D_w for medium energy x-ray beams with an uncertainty of about 1 %.

Dr Ross summarized work at the NRC on calculating the effective point of measurement for cylindrical ionization chambers. This work shows that the shift of -0.6r with respect to the centre of the chamber recommended by several dosimetry protocols is not always adequate. He drew attention to new measurements of k_Q factors for several chamber types for which there is no data in the TG-51 dosimetry protocol. This protocol is currently under revision, and the new data will be used to extend the range of chambers for which it may be used. Finally, he described work at the NRC on the calculations of correction factors for the NRC medium-energy free-air chamber.

9.1 Air kerma

Mr Seltzer reviewed some activities at the NIST that are described in more detail in reports CCRI(I)/09-07, CCRI(I)/09-15 and CCRI(I)/09-17. A program is underway to establish a

method for calibrating the output of "Xoft" x-ray tubes. These are miniature x-ray tubes operating at about 50 kV that can be used instead of brachytherapy sources. A new medium-energy free-air chamber is being constructed to replace the existing standard that has been in use for more than 50 years.

Ms Villevalde summarized work at the VNIIM on cavity chambers for air-kerma standards, as described in report CCRI(I)/09-26. The Monte Carlo code EGSnrc has been used to calculate the wall correction factor and the axial non-uniformity correction factor for two reference chambers used to establish the air kerma for ^{60}Co γ-rays. The new correction factors, along with a re-evaluation of the volume of one chamber, has led to an increase in the VNIIM value of air kerma of about 1 %. A new K1 comparison with the BIPM is planned for 2009.

Dr Delaunay reviewed recent developments at the LNE-LNHB, as summarized in CCRI(I)/09-30. Preliminary results with a new water calorimeter show agreement with the reference value for D_w to better than 0.1 %. Correction factors for the LNHB low- and medium-energy free-air chambers have been calculated using the PENELOPE Monte Carlo code.

Dr Duane stated that the NPL values for air-kerma for ^{137}Cs and ^{60}Co γ-rays would increase by 1 % as of 1 May 2009. This change arises from a re-evaluation of correction factors.

Dr Webb described recent work at the ARPANSA as summarized in CCRI(I)/09-31. Monte Carlo techniques have been used to evaluate the aperture effect for medium-energy x-rays. The effect is significant for 250 kV x rays.

9.2 Absorbed dose to water

Mr Seltzer reviewed activity at the NIST, as summarized in CCRI(I)/09-13. The focus has been on water calorimetry based on repetitive runs with analysis using Fourier-transform techniques. Although most work has been at room temperature, studies at 4 °C are also underway. Present results give values for the absorbed dose that are within 0.25 % of what is expected, based on results obtained using the Domen calorimeter.

Dr Duane stated that significant progress had been made in carrying out calorimetry measurements on the new NPL Elekta accelerator.

9.3 Brachytherapy dosimetry

The CCRI(I) meeting had been preceded by a one-day workshop on brachytherapy, and Mr Seltzer indicated that all of the key points of CCRI(I)/09-16 had been covered during the workshop.

9.4 Radiation processing

Mr Seltzer reviewed recent developments at the NIST, as summarized in CCRI(I)/09-23. Work is progressing on the development of smaller alanine pellets that can be used for small-field dosimetry. There has been a long-term difference of about 1.5 % between comparisons of the NPL and the NIST alanine dosimeters. There is now some evidence that this may be a dose or dose-rate effect.

Dr Pimpinella reviewed recent developments at the ENEA, as summarized in CCRI(I)/09-25. A new ^{60}Co high-dose-rate facility has been installed that can provide dose rates of up to 4.4 kGy/hr. She described the Fricke and dichromate systems that are used to establish the dosimetry.

Dr Delaunay explained that at the LNE-LNHB a new Gammacell has been commissioned and calibrated using alanine, and participation in the high-dose comparison (CCRI(I)-S2) is planned for 2009.

Dr Sharpe reported on work at the NPL to characterize the temperature dependence of alanine at low temperatures. Additional details are given in CCRI(I)/09-22, but it was found that the response of the alanine dosimeter is independent of temperature below about 160 K. Knowledge of the temperature response is important for the radiation processing of pharmaceutical and biological materials, which is often carried out at low temperature.

9.5 Radiometry and dosimetry in the energy range from 1 keV to 60 keV

Dr Ross asked about the correction to the determination of air kerma using free-air chambers that has been identified in recent papers. The effect is larger for low-energy x-rays and is due to the contribution of the first ion pair created by the photon interaction to the measured charge. The average energy to create an ion pair, W, is used to convert the measured charge to air kerma but W only applies to the ion pairs created by the slowing electrons.

Dr Burns showed a graph illustrating the effect from his recent paper in *Metrologia*, and Mr Seltzer showed results he had calculated for realistic x-ray beams, which are in general agreement. For low-energy beams the effect is much larger than the stated uncertainty on the air-kerma determination.

There was some discussion as to whether or not the ICRU key data committee should consider the issue, but Mr Seltzer felt it was not the appropriate venue. Further discussion of the matter was postponed to agenda item 17.1.

9.6 Radiation protection

There were no submissions on standards for radiation protection.

10 DEVELOPMENT OF NATIONAL STANDARDS FOR CHARGED PARTICLE DOSIMETRY

10.1 Electron/beta dosimetry

Mr Seltzer reviewed some of the activities at the NIST related to beta dosimetry as summarized in CCRI(I)/09-14. Two comparisons have been undertaken with the PTB.

Dr Bordy drew attention to possible uses of gel dosimetry for brachytherapy sources.

Dr Duane pointed out that the NPL electron calorimeter cannot be used on the new Elekta linac because the dose rate is too low. In the meantime, they are using the x-ray calorimeter in electron beams until a new electron calorimeter can be designed.

10.2 Protons

Dr Twerenbold reported on measurements by the METAS using water calorimetry at the PSI scanned proton beam. The work showed the potential of water calorimetry in establishing the absorbed dose due to protons, but it is hard to get enough beam time to do precision metrology. METAS hopes to be able to measure k_Q for various ionization chambers to test protocol predictions for proton beams.

Mr van Dijk reported on measurements using the VSL water calorimeter in a proton beam. He also emphasized the difficulty of getting beam time and pointed out that the copper in their calorimeter had become activated during the irradiations.

Dr Carneiro indicated that the CCRI(I) may need to begin planning for possible future needs for proton dosimetry.

10.3 Other charged particles

The NPL has been involved in a collaboration to measure the properties of an anti-proton beam using alanine dosimetry. The results have been published recently.

11 FUTURE TRENDS IN DOSIMETRY

Dr Kühne announced the BIPM Workshop on physiological quantities and SI units to be held 16-17 November 2009. A notice will be sent to all NMIs asking for the nomination of experts to attend the workshop.

11.1 Biological quantities for radiation dose

Guest Lecture: Nanodosimetry – a view on future radiation quantities

Dr Rabus began his presentation by pointing out that radiation effects begin at the level of cellular components, and so it is reasonable to inquire as to how charged particles deposit their energy on the nanometre scale. The effects of the interaction of radiation with living matter are complicated because they involve both a physical and biological component. It is not only for radiation where a physiologically weighted unit has been created (sievert) but a similar approach is used in the response of the eye to light (candela).

At the PTB, Dr Rabus and his group have constructed an apparatus that permits them to measure the number of ions produced in a volume of gas per incident particle. This way, they can measure the ion cluster size and determine the probability of producing a cluster with a given

number of ions. Their work indicates that the cluster size can be used a signature of the radiation quality.

Dr Rabus concluded his presentation by suggesting that nanodosimetry may be a route to future radiation units. In particular, it may be possible to define a biologically weighted fluence, where the weighting factor is derived from measurements of nanodosimetric quantities, such as the ion cluster size.

Dr Rabus drew attention to a workshop on nanodosimetry to be held at the PTB in June 2009. Report CCRI(I)/09-11 summarizes recent activities at the PTB on nanoscale dosimetry. Dr Rabus expressed interest in establishing collaborations to advance the science of nanodosimetry.

11.2 Coordinated projects

There are a number of coordinated research projects related to dosimetry that are underway in Europe. Efforts in brachytherapy were discussed at the one-day workshop, but there is also work related to charged-particle therapy, IMRT and small-field dosimetry.

Drs Carneiro, Kramer, Kühne and Csete drew attention to new European initiatives that may present opportunities relevant to the CCRI(I).

It was noted that Europe seems to be leading the global community in terms of establishing research projects that cross national boundaries.

12 OTHER REPORTS FROM MEMBER LABORATORIES

Dr Maringer reviewed recent work at the BEV as described in CCRI(I)/09-42. The BEV graphite calorimeter has been refurbished and correction factors evaluated using PENELOPE. The calorimeter, which is designed to be portable, was taken for measurements to the PTB and the METAS. Results for ^{60}Co are in satisfactory agreement with expectations. Measurements in accelerator beams present additional challenges because of limited knowledge of the effective source position and the effects of backscatter into the monitor chamber.

Although there was no written report, Dr Peixoto summarized recent activities at the LNMRI/IRD in Brazil. They have undertaken a review of correction factors for their free-air chamber. He pointed out that the work of the laboratory is enhanced by the presence of several graduate students.

13 REPORTS FROM THE RMOS

13.1 AFRIMETS

Ms Msimang reported on the structure and recent activities of AFRIMETS, as summarized in CCRI(I)/09-06. AFRIMETS was formed in 2007 and has 36 principal members. The PTB and the LNE are associate members. It was recognized as an RMO by the CIPM in October 2008.

Ms Msimang stated that the RMO has run some proficiency tests among the member laboratories and is trying to coordinate funding to help support initiatives. The RMO faces a number of challenges such as the difficulty of transporting artefacts across borders and the lack of experts to review CMCs. Dr Allisy-Roberts suggested that the IAEA might be able to provide assistance in reviewing CMCs.

13.2 APMP

Dr Webb reviewed some of the activities of the APMP Technical Committee on Ionizing Radiation (TCRI) as summarized in CCRI(I)/09-04. The TCRI has four working groups, one for each of the three CCRI subject areas, and one to review CMCs. Five comparisons related to photon and electron dosimetry have been active since the last CCRI(I) meeting. One has been completed, and the final reports are being prepared for two others.

13.3 COOMET

Ms Villevalde reviewed recent COOMET activities as summarized in CCRI(I)/09-40. The new graphite cavity chambers for ^{60}Co and ^{137}Cs air kerma measurements, purchased from the MKEH laboratory (Hungary) will be used by the VNIIM acting as the linking laboratory for new COOMET comparisons. It was noted that the chamber volume as determined by the MKEH is used to establish the standard at the VNIIM.

13.4 EURAMET

Dr Csete reviewed recent EURAMET activities as summarized in CCRI(I)/09-12. He drew attention to a EURAMET guide that is intended to help laboratories with the review of CMCs. Dr Csete indicated that he is stepping down as chair of the EURAMET technical committee and that he will be succeeded by Mr Bjerke of Norway.

13.5 SIM

Mr Seltzer reviewed recent SIM activities as summarized in CCRI(I)/09-05. Several members of SIM participated in EURAMET comparisons EUROMET.RI(I)-K1 and EUROMET.RI(I)-K4, and all SIM laboratories participated in a comparison of orthovoltage x-rays (SIM.RI(I)-K3).

14 CIPM MRA CALIBRATION AND MEASUREMENT CAPABILITIES

14.1 Report from the CCRI RMO WG

The next meeting of the RMO working group will be in June. One issue to be discussed is the specification of the 95 % confidence interval in the ionizing radiation CMCs listed in Appendix C of the CIPM MRA. Dr Thomas commented that the RI CMCs are consistently well prepared.

14.2 Report from the JCRB

Mr Mussio reviewed the membership of the JCRB and reported on developments at recent meetings. The March 2009 meeting considered the traceability requirements for CMCs. Mr Mussio emphasized that it is the responsibility of the RMOs to review the CMCs for accuracy and consistency.

A new RMO, called AFRIMETS, has been formed as an expansion of existing RMOs to represent the African continent.

15 REPORTS FROM INTERNATIONAL MEMBERS AND OBSERVERS

15.1 ICRU

Mr Seltzer gave a summary of recent ICRU activity, with reference to CCRI(I)/09-39. Report 80 on dosimetry for radiation processing has been published. Reports on mammography and on quantities and units will be published in 2009. The report on key data should be finished within one year. The commitment by the ICRU to its publisher is to publish two reports per year. Mr Bjerke indicated that the report on IMRT will be reviewed at the next ICRU meeting in Dresden in the fall of 2009.

Dr Sharpe wondered if the ICRU should consider recommendations on how to address the new understanding of how the measured charge in a free-air chamber is related to the air kerma. Mr Seltzer felt this matter was more appropriately dealt with by the CCRI(I), and it was agreed to set up a small task group to look at the science and recommend a way forward. Members of the air-kerma working group are Dr Burns (BIPM), Mr Seltzer (NIST), Dr Büermann (PTB) and Dr Ross (NRC). The group is tasked with preparing a paper in time for the next meeting.

15.2 IAEA

Dr Meghzifene gave a summary of recent IAEA activity, with reference to CCRI(I)/09-29. He described the new bunkers that have been completed at the Siebersdorf calibration laboratories.

He reviewed recent comparisons and new publications, and drew attention to the dosimetry symposium scheduled for the IAEA in November, 2010.

In response to a question from Dr Bordy regarding IAEA quality audits, Dr Meghzifene pointed out that the Agency recommends that treatments be discontinued if discrepancies are greater than 10 %. Dr Hassan praised the willingness of the IAEA to help laboratories resolve problems.

15.3 IOMP

No report was presented.

15.4 IRPA

No report was presented.

16 PUBLICATIONS

16.1 *Metrologia* Vol 2 2009 Special issue on ionizing radiation dosimetry

The special issue of *Metrologia* on the subject of ionizing radiation dosimetry has now been published. Dr Janet Miles, the editor of *Metrologia* and BIPM webmaster, indicated that IOP will publish advertisements for these special issues. A special issue on neutrons is in preparation. She pointed out that *Metrologia* has a respectable impact factor of 1.6.

16.2 NMI bibliographies

Dr Allisy-Roberts thanked everyone for keeping their bibliographies up to date. Dr Sharpe pointed out that the BIPM web site is a very useful resource. It is sometimes easier to find information about an NMI on the BIPM site than from the NMI web site.

17 CCRI(I) MEMBERSHIP CHANGES

Dr Allisy-Roberts outlined the criteria for membership on a consultative committee, as described on the BIPM web site (http://www.bipm.org/en/committees/cc/cc_criteria.html). Laboratories may be represented by “members” or by “observers”.

She pointed out that the GUM (Poland) has not been active in the CCRI(I) for some time and the SSM (Sweden) has not attended for many years and may no longer wish to continue as an observer.

17.1 Applications from the CIEMAT, ITN and NIS

Three laboratories made presentations with a view to becoming observers or members of the CCRI(I).

Dr Los Arcos reviewed the main features of the CIEMAT laboratory, in support of their application for observer status as requested in a letter to Dr Wallard (CCRI(I)/09-03). He noted that the laboratory was divided into two main sections with one focussing on radionuclide metrology and one on dosimetry. A quality system based on ISO 17025 was implemented in 2002, the laboratory has several CMCs, and has participated in three dosimetry comparisons.

Dr Oliveira gave a brief overview of the ITN (Portugal) in support of their application for observer status as summarized in CCRI(I)/09-08. He described the laboratory building and the key equipment and pointed out that they have participated in a ^{60}Co comparison with the BIPM.

Dr Hassan gave an overview of the NIS laboratory (Egypt). He outlined some of their laboratory work and pointed out that their standards are traceable to the BIPM. They are a member of the IAEA SSDL network and have participated in a comparison with the IAEA. They are actively trying to establish primary standards for medium-energy x rays.

The President will support the formal applications for observer status from the CIEMAT and the ITN at the next CIPM meeting.

18 DATE OF NEXT MEETING

This year, the meetings of three sections of the CCRI were spread over the months of April, May, and June to ease the workload on the BIPM. It is proposed to continue this arrangement next time, and the CCRI(I) meeting is tentatively scheduled for May or June 2011.

Dr Carneiro discussed the resolution from the 23rd meeting of the CGPM which asked that the CIPM present to the 24th CGPM options related to dosimetry comparisons and calibrations using a linear accelerator. He felt it may be necessary to schedule an extraordinary meeting of the CCRI(I) in order to formulate an appropriate response.

19 CONCLUDING REMARKS

Dr Sharpe concluded that it had been a very successful meeting and he thanked everyone for their participation. He noted especially the efforts of the BIPM staff and of Dr Allisy-Roberts in hosting the meeting.

The recognition of the 50th anniversary of the CCRI through a review of its history and the invitation of honoured guests, helped to provide an historical context.

Twice during the meeting Dr Allisy-Roberts was presented with flowers in recognition of her extensive contributions to the work of the CCRI. The first presentation was by honoured guest Dr Aalbers and the second by Mr Bjerke.

Dr Carneiro noted that Dr Kramer will be retiring before the next CCRI(I) meeting. He thanked Dr Kramer for his extensive service to the CCRI(I) and presented him with a certificate of appreciation from the BIPM.

APPENDIX R(I) 1.
Working documents submitted to the CCRI(I) for its 19th meeting

Open working documents of the CCRI(I) 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=CCRI(I)

Documents restricted to Committee members can be accessed on the restricted website.

Document CCRI(I)/	
09-00	Draft agenda, 3 pp.
09-01	BIPM. — Meeting report from the KCWG, D.T. Burns *et al.*, 4 pp.
09-02	CIPM. — CCRI Report 2007 to the CIPM, G. Moscati, 6 pp.
09-03	CIEMAT (Spain). — Application for Observer status from the CIEMAT, J.A. Rubio, 2 pp.
09-04	APMP. — APMP/TCRI Activity Summary, Y. Hino and M.-C. Yuan, 4 pp.
09-05	SIM. — Report of the SIM laboratories to the CCRI(I), S.M. Seltzer, 7 pp.
09-06	AFRIMETS. — AFRIMETS Report to the CCRI, Z. Msimang, 2 pp.
09-07	NIST (United States). — Recent dosimetry activities at the NIST, S.M. Seltzer, 33 pp.
09-08	Instituto Portugês da Qualidade (Portugal). — Membership application from the ITN, A. Cruz, 1 p.
09-09	PTB (Germany). — Progress report of the PTB department of Radiation Therapy and Diagnostic Radiology, M. Anton *et al.*, 11 pp.
09-10	PTB (Germany). — Progress report from the PTB department of Radiation Protection Dosimetry, P. Ambrosi *et al.*, 2 pp.
09-11	PTB (Germany). — PTB report on fundamentals of dosimetry, W. –Y. Baek *et al.*, 2 pp.
09-12	EURAMET. — EURAMET RI TC Report, I. Csete, 9 pp.
09-13	NIST (United States). — Update on the NIST second-generation room-temperature water calorimeter, H. Chen-Mayer and R.Tosh, 5 pp.
09-14	NIST (United States). — Update on NIST beta-particle dosimetry standards and calibrations, C.G. Soares, 2 pp.
09-15	NIST (United States). — An update on the NIST program for Cs-137 and Co-60 gamma-ray beams, R. Minniti, 2 pp.
09-16	NIST (United States). — NIST low-energy photon brachytherapy standards and calibrations, M.G. Mitch *et al.*, 2 pp.
09-17	NIST (United States). — Update on NIST air-kerma standards and calibrations, M. O'Brien and S.M. Stelzer, 2 pp.
09-18	NRC (Canada). — IRS-NRC Dosimetry activities report, C.K. Ross, 14 pp.
09-19	LNE-LNHB (France). — New primary standard ionization chambers for air kerma, F. Delaunay *et al.*, 14 pp.

Document CCRI(I)/

09-20 CMI (Czech Republic). — Progress report on photon dosimetry at the CMI, V. Sochor, 2 pp.

09-21 NMIJ/AIST (Japan). — Progress report on radiation dosimetry standards at NMIJ/AIST, N. Saito *et al.*, 9 pp.

09-22 NPL (United Kingdom). — Progress report on radiation dosimetry at the NPL, P. Sharpe and S. Duane, 7 pp.

09-23 NIST (United States). — Update on NIST radiation-processing (high-dose) dosimetry services, M.F. Desrosiers and J.M. Puhl, 2 pp.

09-24 NIST (United States). — NIST-sponsored comparison of standards for absorbed dose to water (radiation processing levels), M.F. Desrosiers and J.M. Puhl, 5 pp.

09-25 ENEA-INMRI (Italy). — Report to the CCRI(I) from the ENEA-INMRI on photon and charged particle dosimetry, R.F. Laitano *et al.*, 20 pp.

09-26 VNIIM (Russian Fed.). — Progress report of the VNIIM, A.Y. Villevade *et al.*, 7 pp.

09-27 VSL (Netherlands). — Progress report on radiation dosimetry standards, facilities and related topics at VSL, E. van Dijk, 3 pp.

09-28 BIPM. — Re-evaluation of the BIPM international standards for air kerma in x-rays, D.T. Burns *et al.*, 4 pp.

09-29 IAEA (Vienna). — Report on IAEA activities for the CCRI(I), A. Meghzifene *et al.*, 19 pp.

09-30 LNE-LNHB (France). — Progress report from the LNE-LNHB, F. Delaunay, 7 pp.

09-31 ARPANSA (Australia). — Recent activities in measurement standards and dosimetry at ARPANSA, D.Webb *et al.*, 7 pp.

09-32 BIPM. — A re-evaluation of the I-value for graphite, D.T. Burns, 6 pp.

09-33 MKEH (Hungary). — Progress report on radiation dosimetry at the MKEH, I. Csete, 2 pp.

09-34 BIPM. — Dosimetry comparisons and calibrations at the BIPM, 2007-2009, P.J. Allisy-Roberts *et al.*, 6 pp.

09-35 BIPM. — Actions arising from the May 2007 meeting, P.J. Allisy-Roberts, 6 pp.

09-36 BIPM. — Re-evaluation of the BIPM international standard for air kerma in ^{137}Cs gamma radiation-revised, C. Kessler *et al.*, 4 pp.

09-37 BIPM. — Progress with the BIPM mammography standards facility, C. Kessler *et al.*, 2 pp.

09-38 EURAMET. — EUROMET 813 comparison Final report for approval, I. Csete *et al.*, 100 pp.

09-39 ICRU. — ICRU Report, S.M. Seltzer, 1 p

09-40 COOMET TC 1.9. — Report from the COOMET, V. Yarina and S. Korostin, 2 pp.

09-MET Special issue of *Metrologia* on Radiation dosimetry (46(2), 2009).

CONSULTATIVE COMMITTEE
FOR IONIZING RADIATION

Section II: MEASUREMENT OF RADIONUCLIDES
Report of the 20th meeting
(17-19 June 2009)

Abstract

Section II (Measurement of radionuclides) of the Consultative Committee for Ionizing Radiation (CCRI) held its 20th meeting at the BIPM headquarters, Sèvres, from 17 to 19 June 2009. Members and observers representing 24 laboratories and organizations were present and participated in discussions on comparisons, reference values, publications, and strategic planning in radionuclide metrology. Reports from six working groups described a variety of activities of the Section, while reports from the RMOs and the laboratories themselves described their technical activities in the field. The long-term strategic planning for radionuclide metrology at the BIPM was discussed and recommendations to the CCRI from Section II were defined. In light of this 50th anniversary of the CCRI, a special seminar entitled "*Fluctuations in Long-Term Stability Measurements of Ionization Chambers*" was given by honored guest Dr Heinrich Schrader.

1 OPENING OF THE MEETING WELCOME

Section II (Measurement of radionuclides) of the Consultative Committee for Ionizing Radiation (CCRI) held its 20th meeting at the Pavillon de Breteuil (the BIPM headquarters), Sèvres, on 17, 18 and 19 June 2009.

The following Members and representatives were present:

D. Alexiev (ANSTO), D. Arnold (PTB), C. Bobin (LNE-LNHB), F. Bochud (IRA), R. Broda (RC), M. Capogni (ENEA-INMRI), K. Carneiro (President of the CCRI), F. Damoy (LNE-LNHB), P. De Felice (ENEA-INMRI), P. de Lavison (NPL), L. Johansson (NPL), L. Karam (NIST), J. Keightley (NPL), J.-M. Los Arcos (CIEMAT), T.S. Park (KRISS), S. Pommé (IRMM), M. Sahagia (IFIN-HH), T. Shilnikova (VNIIM), B.R.S. Simpson (Chairman of Section II, NMISA), J. Sochorová (CMI), L. Szücs (MKEH), M. Unterweger (NIST), U. Wätjen (IRMM), Y. Yuandi (NIM), A. Yunoki (NMIJ/AIST).

Observers:

C. Borrás (IOMP), F.A. Iglicki (CNEA), C.K. Kim (IAEA), F.J. Maringer (BEV), P. Saull (NRC-INMS).

Guests: A. Allisy (c/o BIPM), G. Moscati (c/o CIPM), H. Schrader (c/o PTB), D. Smith (c/o NPL).

Also attending the meeting from the BIPM for all or part of the time: P.J. Allisy-Roberts (Executive Secretary of the CCRI), D.T. Burns, S. Courte, C. Kessler, M. Kühne (Deputy Director), C. Michotte, L. Mussio, M. Nonis, G. Ratel, C. Thomas (KCDB coordinator), A.J. Wallard (Director).

Apologies were received from Y. Hino (NMIJ/AIST) and from C. da Silva (IRD-LNMRI).

Meeting delegates were greeted by Dr Simpson, who noted that the Director of the BIPM (Dr Andrew Wallard) would not be available until the next day. Therefore the Deputy Director of the BIPM (Dr Michael Kühne) welcomed the delegates, noting the celebration of 50 years of collaboration in ionizing radiation and his eagerness to participate in the meeting.

The new president of the CCRI, Dr Kim Carneiro, also welcomed everyone to this special meeting, which had been preceded by five working group meetings. Prof. Giorgio Moscati, previous CCRI President, was especially welcomed as a guest to this special meeting. Dr Carneiro noted that, although he is not a specialist in ionizing radiation, his duty is to report at the meeting of the CIPM where he will give a presentation on what has occurred in the three CCRI meetings as well as in the ten associated working group meetings.

2 INTRODUCTION BY THE CHAIRMAN (Dr BRUCE R. S. SIMPSON)

The chairman gave an especially warm welcome to new comers, and was very pleased to announce that Dr Heinrich Schrader would be giving the anniversary seminar ("Fluctuations in Long-Term Stability Measurements of Ionization Chambers") that afternoon at the close of the day's agenda. Introductions were then made around the table.

The Chairman summarized an historical article from 1984 from the Society for Radiological Protection as part of his introduction, as follows. By the late 1950's, the need to coordinate activities in radiation measurements was evident. Consequently, a Consultative Committee for ionizing radiation (then known as CCEMRI) was formed in 1958 (and met in 1959). The CCEMRI met five times from 1959 through to 1964, and most of the work was done in Working Groups. In 1969, the CC was reorganized into three sections (the 4th section on alpha-energy standards was later folded into section II) which currently meet every 2 years. Section II has the responsibility for radioactivity comparisons. Dr Simpson has been coming to CCRI(II) meetings since 1989 and so had known several chairmen over the years. Dr Simpson himself has been chairman for the past 12 years. The purpose of the meetings of the CCRI(II) is to bring together experts to give input on advances in metrology in the field as well as advice to the CIPM. Laboratories which are invited (generally National Metrology Institutes, NMIs) are considered to be the most expert as exemplified in an active research programme, publications, and competence in measurement comparisons. Section II participants include 19 member laboratories, observers, personal members, *ex officios*, and BIPM staff. Since the establishment of the CIPM MRA 10 years ago, a major focus has been on key comparisons and there has been a great deal of progress in this area. The section has six working groups: Key Comparisons (KCWG), Uncertainties (UCWG), High-Efficiency Photon Detection Systems (HEWG), Extended SIR (ESWG), Realization of the Becquerel (BqWG), and SIR Transfer Instrument (TIWG).

Dr Allisy-Roberts then gave a presentation (including many photos through history) on the membership of the Section II over the years, and noted recommendations from the first meeting of the CCEMRI in April 1959 (with Allen Astin from NBS (now NIST) as President). The second President was Ernie Ambler also from the NBS who was unfortunately unable to attend as a Guest of Honour. Other Guests of Honour from the history of the CC (and Section II) were also given special recognition (in the form of a certificate): Peter J. Campion (first Chairman; *in absentia*), John G.V. Taylor (third Chairman; *in absentia*), David Smith (fourth Chairman; member from 1979-1993), Giorgio Moscati (CCRI President from 1996 through 2007), Heinrich Schrader (for *Monographie* 4), Dale Hoppes (*in absentia*), Robin Hutchinson (*in absentia*), Jean-Jacques Gostely (personal member for over 25 years; *in absentia*), Yoshio Hino (for leadership in APMP comparisons; *in absentia*) and Bruce Simpson (the present and longest serving Chairman of the Section II).

3 APPOINTMENT OF RAPPORTEUR

Dr Lisa Karam (NIST) was appointed as the rapporteur for this meeting.

4 CONFIRMATION OF THE AGENDA

No changes were made, and the agenda was confirmed although the order of some items changed from the originally scheduled agenda.

5 REPORT OF THE 20th MEETING OF THE CCRI (2007), INCLUDING THE 19th MEETING OF THE CCRI(II) AND MATTERS ARISING NOT OTHERWISE ON THE AGENDA

The Chair gave a short presentation summarizing the last CCRI meeting in 2007 (31 May). At that meeting, Prof. Moscati had noted improved functioning of these meetings and was encouraged by the use of the CIPM MRA. The meeting had included summaries on sections I and III as well as II. Specifically, the Chair had given an update on the Section II meeting from that year including: the SIR; the "Measurement methods grouping criteria for radionuclides, to support CMCs" commonly known as the Generic Groupings Table; current and future key comparisons; comparisons of reference materials; the 21 radionuclides whose valid comparisons are about to expire; working group updates; the comparisons/uncertainty workshop to be held the following September; proposed operational schemes for submissions to the extended SIR; the BqWG proposed replacement chamber; progress on the transfer instrument for short-lived radionuclides; the HEWG coordinated by Prof. Winkler, who is currently the only member; BIPM programmes; Section II membership and the new status of the BEV as an Observer; and several discussion points of common interest to all three sections.

The CCRI had made several recommendations, particularly for Section I (changing the name to "x-and γ rays and charged particles") and extending the validity of a CCRI(III)-K1 comparison from 10 years to 15 years).

6 REPORT OF THE KEY COMPARISON WORKING GROUP (WORKING GROUP COORDINATOR: L. KARAM)

Dr Karam gave a presentation updating the Section on the recent activities of the KCWG, including proposed changes to the Generic Groupings Table which may impact CMCs. Dr Thomas gave a brief overview on how to recover each Excel CMC file from the web (for modifications). There were many discussions surrounding the use of the Generic Groupings Table (including instructions to the group to evaluate which supporting comparisons for CMCs could be gleaned from the Table); the Section was reminded to send input on the table to the coordinator of the KCWG.

7 BIPM.RI(II) KEY COMPARISONS

7.1 Present status of the SIR

7.1.1 Update on comparison reports

Dr Ratel gave a presentation on the submission of 11 ampoules containing radionuclide samples to the SIR to give 9 independent results in 2007. Submissions in 2008 were very similar to 2007 with a total for the 2 years of 18 independent results from 20 ampoules. Sixteen submissions are planned for 2009. A total of 9 different radionuclide results are newly registered in the SIR Master file, and 7 comparison results have been published. Other updates on the SIR and comparisons included mention of the SIR transfer instrument and the upcoming external audit (the previous one had been in 2006) of the SIR quality system (including the new electronics for the acquisition system). With regard to the SIR, the new acquisition system electronics have been compared with the old system, which is expected to be phased out by the end of 2009.

A demonstration was given on how to access comparison results on the Web. From the KCDB, a search can be made on a specific comparison. The IOP electronic web pages can be searched for the final reports as published in *Metrologia*; files are also accessible from the BIPM scientific work site as well as in the KCDB. As a particular note, in searching by radionuclide, either format e.g. $^{166}Ho^{m}$ or Ho-166m is acceptable.

7.1.2 Consideration of new results for inclusion in certain KCRVs

Dr Michotte gave a presentation on the proposed changes to the KCRVs as discussed in the KCWG meeting the previous Monday (and reflected in the changes in document CCRI(II)/09-20). Discussions included the need to keep certain non-primary results when not enough primary results exist for a robust KCRV. A particular situation arose with the dramatic change in the KCRV for Zn-65 due to the BARC (India) submission as this is not considered as an outlier based on the current rules. The **accepted** changes are summarized in the following table:

Nuclide	Previous KCRV /year	New Data	Change
^{22}Na	7526 (5) kBq / 2003	NMISA	7534 (7) kBq
^{60}Co	7061.3 (3.5) kBq /2006 7064.6 (3.8) kBq /2003	IFIN-HH, NIST	7063.3 (4.0) kBq
^{65}Zn	29 710 (40) kBq /2004	BARC (per rules)	29 650 (70) kBq
^{75}Se	43 040 (160) kBq /2004	LNE-LNHB	43 050 (160) kBq
^{88}Y	6893 (5) kBq /2004	PTB	6892 (5) kBq
^{99}Tc^{m}	153 140 (330) kBq /2005	LNE-LNHB, PTB	153 240 (220) kBq
^{111}In	43 000 (120) kBq /2003	PTB, LNE-LNHB	43 080 (130) kBq
^{124}Sb	9517 (76) kBq /2003	LNE-LNHB	9567 (27) kBq
^{139}Ce	132 740 (110) kBq /2005	PTB	132 730 (110) kBq

Two particular decisions arose from the discussions surrounding the change in KCRVs.

1 The NMISA's result for Na-22 is higher than a previous submission (due to a subsequent change in the branching ratio value). After some discussion suggesting the reassessment of earlier SIR data in light of recent changes in decay schemes, it was decided that the best solution would be to rely on new submissions replacing the earlier data. It was noted that the decay scheme that is used by the NMI is not currently recorded in the SIR.

2 At the start of the CIPM MRA, it was decided to use unweighted means to calculate the KCRV as there was thought to be not enough common ground in uncertainty budgets that had been produced many years previously. With a view to reconsidering this approach, Dr Pommé was invited to take a differential weighting method using the Zn-65 comparison data including the BARC's result and Dr Johansson volunteered to investigate the smallest coherent subset of data for this comparison applying the approach of Prof. M. Cox. Each would present their findings at the next meeting of the KCWG scheduled for September.

7.1.3 Phasing out of early results (pre-1984) from the KCDB

Dr Allisy-Roberts gave a presentation on the phasing out of results from the KCDB. She stated that the general CIPM MRA rule is that comparison results are valid for 10 years. However, as there are so many radionuclides, the CCRI had adopted an original validity period of 30 years to be gradually reduced to 20 years so that by the end of 2011, all pre-1991 results will be removed from the KCDB. The present situation is that 160 results have been so identified with the NMIs being informed individually when their result is about to be removed from the KCDB. The details will be published in a CCRI document that will be placed in the CCRI(II) working documents on the web site. The Section was also reminded that ionization chamber measurement results may also be sent to the SIR to obtain update degrees of equivalence but these results will not be used in the evaluation of the KCRV.

8 CCRI(II) AND RMO KEY COMPARISONS

8.1 Results and reports of activity measurements

8.1.1 Reports published since May 2007

Dr Ratel stated that the only report published since 2007 was for Fe-55, but that he is working on the other reports from previous years.

8.1.2 Reports for ^{241}Am, ^{55}Fe, ^{89}Sr, ^{32}P, ^{125}I, ^{65}Zn, ^{54}Mn, ^{192}Ir, ^{90}Sr

Dr Allisy-Roberts showed the comparison reports already on the website. The Am-241 results are published although there is no separate final report; the Fe-55 results have been published but the degrees of equivalence are not yet prepared for the KCDB; the Draft A report for Sr-89 is in progress; the Draft B report for P-32 is in progress so the results may be used to support CMCs; the Draft A report for the 2004 I-125 is in progress and needs to be published to replace the 1988 results that will soon be deleted from the KCDB, Draft A reports are also in progress for Zn-65, Mn-54 and Sr-90 while the Ir-192 results are available in the KCDB although the Draft B report is not yet finalized. It was remarked that the electronic template that had been distributed for Fe-55, to aid in report preparation had met with only limited success. These nine comparison reports need to be completed and a discussion ensued regarding the idea of setting up a report-writing working group to help the BIPM finish these reports. Dr Keightley volunteered to help write and to work on the macros that could capture information from the participant electronic reports for the final report if the NPL could support such a secondment. Stefaan Pommé also volunteered to help with this work, which received Dr Wätjen's approval. Currently, there is a thorough assessment of reported components of uncertainty but the question of harmonizing the data was raised. The UCWG could look carefully at the next report and identify areas that may need to be treated as specific research projects.

8.1.3 RMO key comparison reports

The Chairman proposed that discussions on RMO key comparisons would take place during agenda item 8.2.

8.2 Present comparisons

8.2.1 CCRI(II)-K2.Kr-85

Dr Ratel presented progress with the CCRI(II)-K2.Kr-85 comparison. This is an activity by volume comparison of Kr-85 gas for which the volume of all the ampoules was measured at the LNE-LNHB. The comparison had been initiated in response to discrepant SIR results between the NIST and LNE-LNHB. Seven laboratories participated and all the ampoules were measured in the SIR. The characteristics, such as the gas pressure at 70 000 Pa, the use of BIPM gas ampoules and the decay scheme were discussed. Several methods were used including gamma

spectrometry, for example the NPL used both gamma spectrometry and gas counting but only results from primary methods will be used to determine the KCRV. Indeed Dr Ratel explained that he had used only the gas counting method for the NPL to include in the calculating the key comparison arithmetic mean. The provisional results were summarized and no gamma impurities had been observed. The full uncertainty budgets were not presented but will be included in the report. The results illustrated, corrected for the volumes, were consistent, except that the LNE-LNHB appeared to be about 2 % away from the mean at $k = 1$. Two non-identified results however, were complete outliers and these laboratories would be contacted.

8.2.2 CCRI(II)-K2.H-3

Dr Ratel also presented the status of the tritiated water comparison, with eighteen laboratories participating. The 5 g ampoules had been prepared by the LNE-LNHB. The original comparison deadline had been postponed from 31 May to 30 June. The BIPM is using both the CIEMAT/NIST method (using Mn-54 as tracer) and the TDCR but has no results yet. As only five of the eighteen participants had yet submitted their results and in view of the requests then received for further time to undertake measurements and analyses, it was agreed to extend the deadline until 30 September.

8.2.3 CCRI(II)-K2.Lu-177

The NIST is the pilot laboratory for the Lu-177 comparison and Dr Unterweger briefed the group on the status. The deadline had already been extended to 15 July, but there was interest to delay it longer and the CCRI(II) accepted a new deadline of 31 July 2009.

8.2.4 APMP.RI(II)-K2 comparisons

Dr Allisy-Roberts showed the APMP comparisons on the KCDB website. The APMP has just finished a comparison of Ba-133 and had presented a report to the KCWG meeting earlier in the week. The results, presented as a provisional graph, looked satisfactory. The Draft B report would be circulated for final approval. Seven institutions had also participated in an I-131 comparison.

8.2.5 COOMET.RI(II)-K2 comparisons

Three comparisons are in progress and a comparison of Eu-152 activity measurements is planned. The results from the Cs-137 and Am-241 comparisons have been published.

8.2.6 EURAMET.RI(II)-K2 comparisons

Thirteen comparisons are registered in the KCDB, most of which have been published. The Sb-124 comparison is almost complete. It was noted that it is the members of the CCRI(II) who are responsible for reviewing and approving all comparison reports and all published reports are freely available through the BIPM and KCDB websites.

8.2.7 SIM.RI(II)-K2 comparisons

Although there are currently no SIM activity comparisons, some SIM members are participating in the Lu-177 comparison. Dr Karam remarked that there had been some difficulty getting the radioactive ampoules through Customs to one of the laboratories in South America. It was clear that having the correct documentation and procedures in place to export and import radioactive material is crucial for the success of the comparisons. Dr Cari Borrás, observer from IOMP (International Organization for Medical Physics) who had previously worked with the Pan-American Health Organization (PAHO), offered to try to help facilitate export/import to the South American countries in the future via the PAHO.

9 PROGRESS WITH CCRI(II) SUPPLEMENTARY COMPARISONS

The comparison of radionuclide activity in seaweed, CCRI(II)-S1, soil, CCRI(II)-S2 and the IAEA environmental comparison CCRI(II)-S4 have been published. The IAEA phosphogypsum comparison CCRI(II)-S5, with many non-designated participants, is at Draft A report stage. The IAEA piloted Co-57 and I-131 comparisons, CCRI(II)-S6.Co57 and CCRI(II)-S6.I-131 are also at Draft A report stage. It was also stated that when a new comparison is registered even using the same matrix material that had already been compared (seaweed from the NIST, for example), it would be registered with a new designation.

10 FUTURE CCRI(II) AND BIPM (SIR) KEY COMPARISONS

10.1 Recommendations for SIR (BIPM) comparisons

Dr Michotte presented a list of radionuclides with currently no KCRV in the database (Sc-47, Cu-64, Sn-113, Ba-140, Eu-155, Au-195, Bi-207, Am-243), those with only a few primary results, and those with a large spread in primary results. The question arose as to how the community can locate some of these sources to use for comparison purposes. For example, the sole Eu-155 entry is from the NPL and neither Dr Keightley nor Dr Smith could recall its provenance. Similarly, it transpired that Am-243 and Mo-99 were also difficult to obtain as source material to measure although the NIST had obtained the latter in the last year and submitted a new standardization to the SIR. Unfortunately, no specific solution to this issue was identified.

10.2 Recommendations for CCRI(II) comparisons

10.2.1 Ten-year plan

Dr Allisy-Roberts reminded the group of the original 10-year plan for comparisons CCRI(II)/05-12 that had been informed by the degrees of difficulty in the Generic Groupings Table and which would provide comparison support for the majority of radionuclide CMC claims. Some modifications had been made since and the KCWG had proposed a Pu-241 to be piloted by the NPL. It was agreed to support this comparison of beta emitter activity as a CCRI(II) comparison. In spite of the recommendation to run only one comparison per year, there were currently three comparisons in progress, Lu-177, Kr-85 and H-3 and the proposed Pu-241. In addition, the SIR transfer instrument was now operational and would enable the Tc-99m comparisons to proceed. It was agreed that these comparisons would suffice until the next CCRI(II) meeting.

Of particular note was the presentation given by Dr Michotte summarizing the status of the SIR transfer instrument (TI) and the TI working group report.

The principals of the TI-based comparison (measurement of Tc-99m on site at each NMI) were reviewed, as was the structure of the instrument itself. The approach depends on ratio counting to a Nb-94 source, Nb-93m being used to define the threshold before each measurement. Stability checks have shown the instrument to be stable to within 10^{-4}. The value of interest is the SIR TI equivalent activity (A_E) based on the activity times counting ratios similarly as for the SIR. Corrections are made for Mo-99 breakthrough from Tc-99m generation based on the response of the TI to Mo-99 measured using a Mo-99 ampoule from the NIST. After linked measurements to the SIR using Tc-99m ampoules from the LNE-LNHB and the NPL, a trial comparison was run at the NPL. Although the NPL results are correlated, they looked very promising. The TIWG met in March 2009 and the formulae for the live-time correction specific to short-lived radionuclides obtained from the NRC (Baerg) and the LNE-LNHB (Chauvenet) were compared with NIST's *Mathematica* calculations with excellent agreement. Some comments were made on whether it would be better to dilute the source to be measured, rather than waiting for it to decay to reduce activity. Although this would minimize the signal from Mo-99 this would increase the uncertainty component due to the dilution. The protocol agreed for the BIPM.RI(II)-K4.Tc-99m comparison has been posted on the KCDB web site. The first comparison took place at the NIST in May 2009 and the result linked to the SIR agrees with the KCRV within the preliminary uncertainty, the final uncertainty budget of the TI awaiting some Monte Carlo estimations. A discussion took place about ampoule cleaning procedures to prevent droplets forming on the ampoule walls and the NMIs agreed to share their cleaning methods.

10.3 Registration of new RMO key comparisons

The SIM is considering Ba-133 and Na-22 activity key comparisons in 2010.

A question arose regarding supplementary comparisons as the IRMM had sent information to the KCWG regarding a proposal for an activity comparison based on a dried-fruit matrix of bilberry from the Chernobyl region but had not registered the comparison. The group was reminded of the necessity to register all comparisons prior to their commencement if they were for publication under the CIPM MRA. Registration is straightforward from the JCRB website where the registration form may be downloaded. The completed form, once approved by the RMO TC

Chair, should be sent to the BIPM together with the protocol to register the comparison and obtain the approval of the CCRI.

Dr De Felice gave a presentation on a proposed ICRM comparison of large area reference sources (emission rate comparison). The ISO/IEC international standards describe the calibration of surface contamination monitors using such sources and measuring emission rate (ISO 8769). A draft proposal from the RMT (Radionuclide Metrology Techniques) WG of the ICRM has been developed, and the comparison is ready to begin. It is open to any interested parties (not only NMIs but also secondary laboratories and manufacturers), but is expected to be run according to CIPM MRA comparison rules. The measurand is to be alpha and beta particle emission rate, although activity values may also be submitted, for C-14, Cl-36, Sr-90/Y-90, an alpha emitter (perhaps Am-241). The source platform is a 15 cm × 10 cm or 10 cm × 10 cm anodized aluminum sheet that is currently being prepared. There was a suggestion from Dr Yunoki to add Co-60 to the suite of radionuclides, although it is not included in the ISO standard for this reference source. There was some uncertainty as to whether the sources being produced would meet the ISO homogeneity standards of the existing or the stronger requirements of the revised ISO 8769 standard. The chosen sources would be circulated in a serial fashion and several NMIs expressed an interest in participating, including the PTB and the NIST. A proposal will be circulated once the protocol has been written and it was noted that the comparison could take one year or longer depending on the number of laboratories that wish to participate. There is additional information on the ICRM RMT website. The CCRI(II) accepted that this comparison could be run as a CCRI(II) supplementary comparison.

Dr Wätjen then detailed the bilberry supplementary comparison that he had proposed as a CCRI(II) supplementary comparison and this was accepted by the CCRI(II). Several laboratories, including the NIST, NPL, PTB and the ENEA registered their interest and other participants would be welcome. The matrix is a powdered material containing bilberries from the Chernobyl region – six bottles of 100 g each will be distributed to enable for six independent analyses per participant. The activity levels of Cs-137 and Sr-90 are to be measured.

Dr Alexiev briefly discussed a proposal for a supplementary comparison of Y-90 microspheres as used for medical therapy. There was general discussion of some of the potential difficulties such as the influence of the chemistry of the material in the extraction of the activity, and the difficulty in obtaining adequate material for a full-scale comparison, but the decision was to accept the registration of this comparison as a CCRI(II) supplementary, in principle, as long as Dr Alexiev could obtain enough microspheres and submit the protocol to register the comparison.

Dr Park of the KRISS reported that he was running a comparison of radionuclide activities in a rice matrix including the IAEA, IRMM, NIST and the NPL as participants, which had not yet been registered. The comparison itself of Cs-137 and K-40 activities is still open and, since the results have not yet been revealed the CCRI(II) accepted that this could be registered as a CCRI(II) supplementary comparison as long as the CIPM MRA formalities were now followed.

11 WORKING GROUP REPORTS

The Chairman referred to his introduction and the article from 1984 and the recognition therein that most of the then-recent comparisons showed almost no improvements in results over earlier comparisons. Therefore, working groups had been established to address specific issues, many of which unfortunately, still remain today.

11.1 Uncertainties (UCWG; Working Group Coordinator: M. Unterweger)

The coordinator gave a brief presentation on the membership, the WG remit (including the role to evaluate the uncertainties in the Generic Groupings Table), and its activities (e.g., the Key Comparison/Uncertainties Workshop in 2008). Some issues arising from the CMCs submissions were included such as the use of the expanded uncertainty, $k = 2$, as needed by the end-user community, and the need to enter a value for "Level of Confidence", which had actually been updated to "~ 95 %" in all published radionuclide CMCs at the RMO CMC WG meeting the previous Friday, and also the preference for using the standard uncertainty for comparisons, $k = 1$, but the acceptance of $k = 2$ for determining degrees of equivalence. The WG had also discussed uncertainty components, issues concerning the relative sensitivity coefficient, the use and abuse of type A and type B uncertainties, the GUM, and input distributions when producing an uncertainty budget. It was proposed that comparison participants should provide more details regarding their uncertainties, including the method of determination. It was also suggested that the BIPM could set up a repository for documents and software packages used in the evaluation of uncertainties. Dr Karam said she would contact Prof. Winkler regarding the $4\pi\gamma$ method and its status as a primary method. As a result the BIPM was requested to revise all comparison reporting forms to include relative sensitivity coefficients and better descriptors for uncertainty components.

A comparison exercise was proposed to evaluate uncertainties in coincidence measurements using the same data set. This would be organized by the IRA and the NPL later in the summer (see also 15.3).

A brief discussion concerning the use of sensitivity coefficients reported in the tritium comparison came to the conclusion that the topic was still immature.

11.2 Realization of the becquerel at the basic level (BqWG; Working Group Coordinator: U. Wätjen)

The coordinator gave an extensive presentation on the concept of the WG to develop a system to replace the SIR, if necessary, which can be reproduced at any time and in any place with well-specified parameters. Several decisions taken at the WG meeting in December 2007 (inner wall diameter 50 mm, welded joins, argon gas at 2 MPa) were incorporated into the design and key issues were decided, such as which radionuclides, activity ranges, wall material, material specifications, and the ampoules to be used (the effects of the structure of the glass ampoule was identified as being primarily from the side wall thickness variations and not from an irregular base). He described various difficulties with the prototype chamber: the complex source holder

could not be positioned precisely; defining the sensitive gas volume was difficult; the complexity of basic structures made mounting and testing more difficult; the behaviour of critical components to welding were also problematic. Indeed, he explained that the prototype actually needed to be redesigned, with optimized tolerances.

A schematic of the new design concept was presented, which included a better definition of the measurement volume, improved construction and assembly with the use of a tube-through the system rather than the present concept of a beaker-holder design) and some other advantages. Plastic materials will no longer be used and the concept of a welded chamber will be kept. Monte Carlo calculations and experiments now need to be made to confirm the optimum design before a new chamber can be built. The discussion as to whether traceability to an absolute current measurement (pA/MBq) would be better than to an equivalent activity to Ra-226 should be resolved after another phase of simulations and demonstration of an improved electric field distribution. The Working Group will need to develop a detailed technical design and gain experience in mounting with insulators. The next meeting of the WG is scheduled for the week of 26 April 2010.

The time scale for the new prototype was discussed as it was evident that with a change in design it was now unlikely that a new system could be produced before 2012. However, this could still match with the BIPM 2013 to 2016 programme. Questions were also raised about the possibility of measuring pure beta emitters and whether the manufacturing costs had been considered. The proposal is to build several chambers at different laboratories to check the consistency of production at different sites. The WG was asked to consider the measurement of ^{125}I although this might make the design more expensive.

11.3 Extension of the SIR to pure beta emitters (Working Group Coordinator: J.-M. Los Arcos)

The coordinator gave an extensive presentation on the objective to develop a self-consistent scheme for including alpha and beta emitters within the SIR to establish an extension of the SIR (ESIR). He introduced the membership, outlined the standing actions of the WG and gave an overview of the principles for an ESIR operation. Two comparison approaches are proposed: an efficiency/activity calculation, and empirical measurements with comparison of apparent efficiencies.

A key issue is the need for a reference cocktail to avoid artefacts noting that there have been problems with producing a stable, useable scintillator. The intention is to postpone the production of a *Monographie* until the technical procedure for the ESIR is established. Several activities are planned to help clarify the cocktail situation. Samples of the cocktail, XAN6040, will be sent to the NIST for testing with H-3, Ni-63, Fe-55, Sr-90 and Am-241, and to the NMISA, CIEMAT and the BIPM for a cross-check with Ni-63. After some further discussion, the plan was established for original sources to be sent to the BIPM for preparation using the reference cocktail and CIEMAT/NIST measurements at the BIPM. This would avoid difficulties with the stability of the cocktail if sent as prepared LSC sources by the participants. Ultimately and ideally, however, the submitting laboratory would send a prepared sample to the BIPM for measurement in the ESIR so there would be no longer be a need for source preparation at the BIPM.

Early tests of XAN6040 prepared at the BIPM (CCRI(II)/09-21) were not satisfactory in terms of reproducibility, stability or efficiency. There was some discussion on the impact of weighing in low humidity (at least 48 % is required to minimize evaporation) in the preparation of the scintillator and the latest tests at the BIPM at about 40 % humidity showed much better agreement.

The WG will next meet in Bratislava in September 2009.

11.4 High-efficiency photon detection systems (Working Group Coordinator: G. Winkler)

Dr Allisy-Roberts has been in communication with Prof. Winkler to encourage him to prepare the *Monographie* on high-efficiency detection systems. As Prof. Winkler will retire in September 2009, it is hoped he will be able to find more time to write the document and would be invited to do this at the BIPM. However, the completion date was not expected to be before 2010. Drs Pommé and Maringer volunteered to help with writing the *Monographie* and their offers were gratefully received.

11.5 SIR Transfer Instrument (Working Group Coordinator: C. Michotte)

This presentation had been given under agenda item 10.2.1.

11.6 Report on Comparison/Uncertainties Workshop (S. Pommé) (previously agenda item 14.2)

Dr Pommé gave a brief summary of the successful Workshop held in September 2008 at the BIPM, which about thirty-five participants had attended. He briefly described the conclusions of several presentations that had been given including his own “PomPlots” of the results in the KCDB that suggest several underestimations and even some overestimations of uncertainties; that a good understanding of the correct shape factor is needed to apply the TDCR method to beta emitters; that there are different philosophies regarding how uncertainties should be handled including sensitivity coefficients; that uncertainties can be greatly influenced by the quality of the radionuclide source and source preparation; that the uncertainty arising from weighing may not be thoroughly considered but rather underestimated which indicated a need for guidance on uncertainties in weighing; and, that Monte Carlo methods can assist with evaluating uncertainties. It is evident that the most important sources of uncertainty are not always easily identified, and that a lack of knowledge usually leads to falsely small uncertainties. He quoted that in the end, the only certainty is that uncertainties are uncertain. Feedback on the workshop from the participants was entirely positive.

12 CURRENT AND FUTURE BIPM PROGRAMME

Dr Allisy-Roberts gave a presentation describing the activities in radionuclide metrology at the BIPM since the last CCRI(II) meeting in 2007, all of which are reported in the Director's report on the website. The 2008-2009 activities are expected to be approved during the forthcoming CIPM meeting following which the report will also be available. Dr Allisy-Roberts recalled the activities of the activity measurement team, and the extensive work surrounding the SIR, including an update to the acquisition electronics which will replace the old system by the end of the year, and which will then have been cross-compared with the old systems for the past two years. She also highlighted the donation of 5000 SIR ampoules from the NPL. They have also been investigating approaches to extend the SIR to beta emitters using both the TDCR method and the CIEMAT/NIST method. She reminded the CCRI(II) of the successful work to extend the SIR to short-lived radionuclides using the TI and the important role of gamma spectrometry in identifying impurities in submitted ampoules. She also informed the group of the upcoming external audit of the SIR QS. She outlined the collaborations with many NMIs and the variety of publications from the group in the last two years.

Dr Allisy-Roberts continued her presentation by addressing the rest of the 2009-2012 programme for the Ionizing Radiation Section at the BIPM. She forecasted that these years would see about 60 submissions to the SIR, improved impurity measurements following the calibration of the HPGe spectrometer, and the extension of the SIR to the measurement of pure beta emitters, possibly using both the TDCR and CIEMAT/NIST LSC methods and even extending the latter to low activity levels with the new LSC counter 2012. In addition, the SIR transfer instrument, already used for the measurement of Tc-99m with the NIST would continue for other distant NMIs while also being developed for F-18 comparisons. The Section now has responsibility for thermometry due to its needs in calorimetry, and continues to work toward the establishment of a facility for measurements to support the radiotherapy accelerator-user community, which is naturally in competition for resources with other BIPM metrology activities. The role of the BIPM in linking comparison results and providing primary standards for dosimetry and radioactivity in the context of their metrology science strategy was discussed. Future developments in science such as dielectric-wall accelerators, laser-generated radionuclides, better radiobiology and radiochemistry could lead to more cross-discipline activities which would influence the NMI and the BIPM programmes. The suggestion of establishing Working Groups for strategic planning and/or training was discussed briefly, with the conclusion that there are already enough CCRI working groups and each is responsible for addressing strategic planning and training appropriate to its function.

Finally, the proposed programme for 2013 to 2016 was presented (CCRI(II)/09-32). The Section's specific tasks were discussed, these being to maintain the SIR, gamma spectrometry for impurity analyses, BIPM measurement standards for absolute activity, and the transfer instrument for Tc-99m on-site comparisons as well as ensuring the organization and detailed analysis of key comparisons for CCRI(II) and studying and publishing recommendations on the reduction of uncertainties in the measurement of activity. The proposed new developments specifically:

1. developing the transfer instrument to medical and other short-lived radionuclides such as F-18, C-11, Ra-223, Sm-153, At-211, Cu-64 and O-15 with some interest for Mn-56;

2. setting up new absolute measurement facilities with either a large NaI(Tl) well-type or a CsI(Tl) sandwich detector at the BIPM for robustness in measurements;
3. construction of one or more ionization chambers of the BqWG design as an eventual backup for the SIR; and
4. extending the SIR to pure alpha emitters, low-energy gamma-emitters and electron capture radionuclides;

were prioritized in the order now given above with the first two of equal priority and the alpha-emitter ^{211}At being added to the list of short-lived radionuclides at the request of Dr Borrás, noting that it was likely that ^{211}At would become more commonly used in immunotherapy for cancer treatment. A note was made that, although these projects are prioritized, they are all important while recognizing that the lowest priority items may have to be dropped.

The Section was also encouraged to increase collaborations with the ICRM and to pilot CCRI(II) comparisons using high-efficiency well-type detectors. Dr Allisy-Roberts reminded the CCRI(II) of the limited staff resources being currently 2.5 scientists and 2 technicians in radioactivity, and encouraged the CCRI(II) to consider options to help provide support through sponsorship in which contributions of equipment are provided, or secondment when staff are provided by an NMI to the BIPM for a limited period to help realize the high priority recommendations. Such contracted secondees although supported by the home institution are provided with travel and living expenses by the BIPM.

Further discussion on this agenda item took place the following day when Dr Allisy-Roberts distributed the revised summary proposal for the 2013 to 2016 BIPM programme (CCRI(II)/09-32) and the order above of the four new developments proposed. The group reiterated the importance of maintaining the current programme including the extension of the SIR to pure beta emitters. The CCRI(II) then accepted the modified BIPM 2013 to2016 programme.

13 NMI RESEARCH PROJECTS

13.1 VNIIM

Dr Shilnikova gave a presentation on the progress at the VNIIM in radioactivity, including improvements of primary standards, international cooperation, their quality system and calibrations. The VNIIM acts as pilot laboratory for COOMET comparisons, and has developed a new standardization method (a new set up of NaI(Tl) in a sandwich configuration for $4\pi\gamma$). They have planned to implement TDCR for pure β and electron capture but have been having some difficulties and would appreciate some assistance even in the form of information on available commercial systems.

13.2 IFIN-HH

Dr Sahagia gave a presentation on some of the significant activities of the laboratory in the last two years, including that 34 CMCs in radioactivity have been published. They held a workshop for Nuclear Structure and Decay Data Evaluations (ENSDF-2009) which also had training sessions on data evaluation, and have made contributions to *Monographie* 5 and ENSDF (in cooperation with the IAEA).

13.3 NMIJ

Dr Yunoki gave a presentation overviewing APMP comparisons of Kr-85, Ba-133 and I-131 activity measurements. For the Kr-85 comparison, a large (2 m^3) balloon was used for the source. He also gave an overview of the standardization and calibration services at the laboratory, including a new remote (internet-based) calibration service and distributed a brochure on this service. He went on to describe the laboratory's I-125 brachytherapy air kerma service using a free air chamber similar to NIST's WAFAC, work that is normally presented at CCRI(I) but it is the radioactivity group that has responsibility for this at the NMIJ; plans for 2009 and 2010 were also presented.

13.4 IRA

Dr Bochud gave a summary report on the IRA which is a designated institute, and described their recent purification of Ho-166m now registered in the SIR; the half-life was measured using a mass spectrometry but due to the erbium impurity gave equivocal results and measurements will be continued. He also described the laboratory's efforts in developing TDCR capabilities and the new development of $4\pi(\beta\text{-}\gamma)$ capability using an existing large well-type NaI(Tl) system which had been used to measure F-18, Cs-134 and Ba-133. Jointly with the NPL, they are about to send out a notification for an interlaboratory comparison of uncertainty evaluation.

13.5 LNE-LNHB

Dr Bobin gave a presentation on the status of the laboratory. The renovation begun in June 2007 was completed in April 2009. They are moving to the use of digital instrumentation for primary measurements and a first comparison attempted with Cs-137 gave encouraging results. He also presented the results using the analogue MAC3 for TDCR to measure Am-241, Co-60, H-3 and Fe-55. The issue of the increase in coincidence resolving time which differs between radionuclides and is dependent on the cocktail was mentioned.

14 TRENDS AND FUTURE METROLOGICAL NEEDS

14.1 Update of roadmaps

This item had been added to the agenda to encourage the Section to think about roadmaps and strategic planning for better long-term planning. The general discussion raised the following plans: the NIST is expanding its efforts in medical imaging; the NMISA is expanding efforts to develop standards for F-18 for South Africa's accelerator programmes; the NIST has a newly-developed calibration for Ge-68 radionuclide and is planning to submit a source to the SIR in 2010; a check of dose calibrators in Switzerland has shown them to be within a few per cent, which was felt to be inadequate for nuclear medicine; the ANSTO has seen similar problems in dose calibrator response and while the ENEA suggested that the users should address these differences, the NPL has a plan to develop a protocol via a user forum to aid all users. In general, it was felt that full communication with the user community is the way forward.

The discussion then changed to the issue of traceability in medical exposure. New safety standards coming from the revision of the international Basic Safety Standards (BSS) will require traceability in medical applications of radiation. Indeed it was noted that basic safety standards for calibration of medical sources are helping to make medical doctors more aware of the issue of traceability.

On the scale of the next 10 to 20 years, the ANSTO would like to see more internet-based resources for training and remote calibration and instrument control, to avoid staff having to travel.

It was agreed that long-term prediction is a difficult topic but the general view was that metrology for medical imaging would become more important in the future.

14.2 Comparisons and Uncertainties Workshop report

This report had been presented under agenda item 11.6.

14.3 ICRM 2009 progress report

Dr De Felice gave an update on the 2009 International Conference on Radionuclide Measurement (ICRM 2009) to be held in Bratislava, Slovakia in September. The scientific committee was currently reviewing the submitted papers. The conference is held every two years to enable reporting of scientific work from secondary laboratories as well as the primary NMIs; oral and poster presentations will be held, and several working groups, including some of the CCRI(II) WGs will meet during the conference.

14.4 NMI collaborations

The term, “EURANET” was a confusing misprint as this actually referred to “ERA-NET plus”, the European Commission support for the European Metrology Research Programme (EMRP) that is a metrology-focused European programme of coordinated research and development that facilitates closer integration of national research programmes. It was reported that the next area of interest will be metrology for the field of energy and the EURAMET was heavily involved in this.

Other NMI collaborations were also discussed. The Virtual European Radionuclide Metrology Institute (VERMI) comprised of the NPL, PTB, IRMM and LNE-LNHB, is planning a training workshop to be held in Turkey during the first week of November. Twenty trainees from Turkey and twenty young radionuclide metrologists from other countries will attend. It was noted that the Turkish Atomic Energy Authority (TAEK) is designated by the UME for radionuclide metrology in Turkey. The VERMI had held a previous workshop in 2004 on secondary standardization techniques.

15 REGIONAL REPORTS

15.1 RMO activities: AFRIMETS (incorporating SADCMET), APMP, COOMET, EURAMET, SIM

The Working Documents from the AFRIMETS (CCRI(II)/09-17), APMP (CCRI(II)/09-09) and the COOMET (CCRI(II)/09-22) and the SIM report (CCRI(II)/09-10) are all available. Dr Karam mentioned that the SIM will be having a TC meeting in November in Brazil, and she welcomed the CNEA to the CCRI(II) as an observer.

The EURAMET has a new TC chair in Hans Bjerke from Norway, and he reported that this RMO is now a registered entity in Europe (EURAMET e.V.). The theme for the current submissions for research funding is energy and joint funding of 34 M€ is expected. Research calls are open and can include non-EU partners who would be expected to contribute at their own cost. The 2010 research programme is expected to attract more funding, about 90 M€, and the themes will be environment and industry so there may be a focus for radiation projects in health, environment and safety. There may be a possibility in the second identified call for programmes in health in either 2011 or 2012 for an applications-focused joint project. The EURAMET summary (available at CCRI(I)/09-12). It was noted that the CIEMAT has 52 CMCs rather than the 97 reported in the table.

15.2 CCRI RMO WG on CMCs

The participants of the CMCs WG were identified by Dr Karam, who also gave a short history on the CMC publication and review process (including JCRB resolution 22/2). She and Dr Allisy-Roberts demonstrated how to download each Excel CMC file from the JCRB restricted site for editing. The access codes for NMIs are available from each TC Chair. It was noted that any changes to be made should be indicated in bold red (instructions are given in the document CIPM MRA-D-04, chapter 12) for ease in reviewing the edited version. Originally, no particular level of confidence had been specified for the radionuclide measurement CMCs, all submissions stated $k = 2$. The default in the KCDB is then to have "not specified" in this column. At the request of the NRC and after considerable debate, the decision was made at the RMO WG meeting to replace all the "not specified" in this column with "~ 95 %" immediately, and all future CMCs would have such an entry for this field. It was also noted that column P, "key comparisons supporting this CMC claim," now needs to be completed with such information and that the comparisons that support other radionuclides using the same generic method identified through the "Measurement methods grouping criteria for radionuclides, to support CMCs" commonly known as the Generic Groupings Table can be used for this purpose. The document CIPM MRA-D-04 was presented and Dr Karam noted the most important points as well as explaining how changes are made to the CMCs.

Dr Wätjen asked to change the country code for the IRMM from EU to EC but Dr Kühne suggested that whether the IRMM is part of the EU or EC is a political issue similar to the status of the PTB as part of the German Government that is part of the EC and a member of the EU. Dr Thomas requested that a formal communication from the IRMM be sent to the Director of the BIPM before any such change could be made.

15.3 RMO supplementary comparisons to be registered

A question arose as to whether the comparison of uncertainties evaluation (see § 11.1) should be a registered comparison. Noting that to be published in the *Metrologia Technical Supplement*, it must be registered, the CCRI(II) accepted that the comparison proposed to compare the evaluation of uncertainties should be registered as a supplementary comparison of the CCRI(II), piloted by the IRA.

16 INTERNATIONAL REPORTS (IAEA, ICRU, IOMP, IRPA)

Dr Borrás gave a presentation describing the membership, committees, publications, programmes for developing countries, educational activities, professional and scientific activities of the International Organization for Medical Physics (IOMP), and explained why the IOMP is participating in the CCRI. She also discussed the usefulness of the IOMP as input to work plans as representing a large end user community of medical physicists and others.

The IAEA (CCRI(II)/09-37), ICRU and the IRPA did not give formal presentations.

17 PUBLICATIONS

17.1 *Metrologia* special issue on radionuclide metrology – report on its publication

A short overview on this special issue of *Metrologia* (on Radionuclide Metrology) published in August 2007 (Vol.44, No 4), including a brief history of its development and production, was given by the Chairman. Topics covered in this issue included the CIPM MRA, the state of the art in measurements and traceability. It is the first of a trilogy of special issues on radiation metrology, the second, on dosimetry from Section I, having been published very recently. Dr Miles (editor of *Metrologia*) explained how these special issues are considered to be important reference documents with each paper of the Radionuclide Metrology special issue already having been downloaded at least 200 times. The NMIs of the CCRI(II) are encouraged to publish their future research papers in *Metrologia*.

17.2 BIPM Monographs and future projects

The BIPM monographs were identified and members were encouraged to use them, particularly *Monographie 5* that contains radionuclide decay schemes. The Monographs are all downloadable and *Monographie 5* is indexed to make it easier to locate the radionuclide sought. A note was made that the radionuclide metrology community needs to verify that the correct

nuclear data, as published, are being promulgated in their NMIs. A comment was made that the ICRP recently published report on nuclear data needed to be checked against that in *Monographie 5*. Future monographs were planned to include one on solution stability in radionuclide metrology and Ron Collé from the NIST was noted as a possible contributor. The monographs on high efficiency detectors and on the extended SIR were also noted.

The importance of commenting on the IAEA basic safety standards that are in revision was discussed and the NMIs were encouraged to send their comments to the IAEA.

17.3 CCRI(II) bibliographies

The NMI bibliographies are available on-line and the CCRI(II) was reminded of the need to send updated bibliography lists to Dr Allisy-Roberts so that these can be kept current. The lists do not usually contain published references that are more than 5 years old unless they are fundamental reference works. It was noted that the smaller laboratories may wish to keep their earlier publications for longer as evidence of their research capabilities. It was also noted that BIPM historical publications are also maintained on the BIPM web site.

18 NMI LABORATORY REPORTS (TO BE NOTED FOR THE RECORD)

The NMI laboratory reports are normally open access to enable all the NMIs to follow the work of their colleagues in other countries, with the view that this helps with knowledge transfer and research collaboration.

19 CCRI(II) MEMBERSHIP ISSUES

19.1 CCRI Membership

Dr Allisy-Roberts gave a brief presentation on the criteria for membership and the status of current membership. Noting that the criteria include research publications, involvement in the CC activities and comparisons in particular, she highlighted these contributions of each member. It was noted that the SMU (Slovakia) has participated in comparisons and has published CMCs. The CCRI(II) approved the proposal to invite Dr Švec of the SMU to the next meeting as a Guest, prior to any application from them for Observer status.

19.2 Working Group Membership

All working groups are required to submit their remit to the CCRI(II) which defines the planned outcome, work schedule and membership. These will be sent to the CIPM. Each working group must also submit a report to the CCRI which in turn reports to the CIPM through its President

and the meeting Minutes. It was noted that there have been some significant changes in the TIWG membership due to internal changes at the NMIs.

20 DATE OF THE NEXT MEETING

Although the CIPM will finalize the dates, the CCRI(II) recommended that their next meeting should be in 2011. It was noted that it had not been possible to have all three section meetings around the same time this year as in the past because with the growth of issues to discuss and the need for working groups to meet, each section now requires about a full week for their associated meetings. Consequently, Section II proposed to meet during one week in June or July 2011.

The meeting was then closed by the Chair in conveying his thanks to the BIPM, to the Executive Secretary and BIPM team, to the rapporteur, and to all delegates for their contribution and participation. The CCRI President, Dr Carneiro also conveyed his thanks to all present for his initiation into the field of activity measurements, and said that he will report the CCRI activities to the CIPM in October.

APPENDIX R(II) 1.
Working documents submitted to the CCRI(II) for its 20th meeting

Open working documents of the CCRI(II) 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=CCRI(II)

Documents restricted to Committee members can be accessed on the restricted website.

Document CCRI(II)/	
09-00	Draft agenda, 3 pp.
09-01	BIPM. — Thank-you letter to the NPL, A.J. Wallard, 1 p.
09-02	CCRI(II) UCWG. — Remit of the Uncertainties Working Group, M.P. Unterweger, 1 p.
09-03	CCRI(II) UCWG. —2008 report of the UCWG to the CCRI(II), S. Pommé, 6 pp.
09-04	CCRI(II) KCWG. — Remit of the KCWG(II), L.R. Karam, 1 p.
09-05	CCRI(II) KCWG. — Report of the KCWG(II) December 2007, L.R. Karam, 6 pp.
09-06	CCRI(II) KCWG. — Summary report from the KCWG - 2008, L.R. Karam, 5 pp.
09-07	CCRI(II) KCWG. — Generic Groupings Table 2008, L.R. Karam, 7 pp.
09-08	CIPM. — Report of the CCRI President to the 2007 CIPM, G. Moscati, 6 pp.
09-09	APMP. — APMP/TCRI Activity Summary, Y. Hino and M-C. Yuan, 4 pp.
09-10	SIM. — Report of the SIM laboratories to the CCRI(II), L.R. Karam, 7 pp.
09-11	IFIN-HH (Romania). — Report of the IFIN 2009, M. Sahagia, 6 pp.
09-12	AFRIMETS. — AFRIMETS Report to the CCRI, Z. Msimang, 2 pp.
09-13	NIST (United States). — Report of the NIST to CCRI(II), L.R. Karam, 26 pp.
09-14	NMISA (South Africa). — Review of the activities of the NMISA, B.R.S. Simpson *et al*, 2 pp.
09-15	CCRI(II) TIWG. — Remit of the Transfer Instrument WG(II), C. Michotte, 1 p.
09-16	ANSTO (Australia). — Report from the ANSTO, D. Alexiev *et al.*, 2 pp.
09-17	VNIIM (Russian Fed.). — Report from the VNIIM, T. Shilnikova *et al.*, 3 pp.
09-18	IRA-METAS (Switzerland). — IRA-METAS Report, F.O. Bochud, 2 pp.
09-19	BIPM. — Recommendations for SIR comparisons, C. Michotte, 1 p.
09-20	BIPM. — Proposals for KCRV updates - revised, C. Michotte, 6 pp.
09-21	BIPM. — Tests of XAN6040 at the BIPM, G. Ratel and S. Courte, 3 pp.
09-22	COOMET TC 1.9. — COOMET Report, V. Yarina and S. Korostin, 2 pp.
09-23	IRMM (Belgium). — IRMM Report, U. Wätjen, 6 pp.
09-24	CCRI(II) TIWG. — Report from the TIWG, C. Michotte *et al.*, 7 pp.
09-25	NMIJ/AIST (Japan). — Progress report from the NMIJ in radionuclide metrology, A.Yunoki, 2 pp.

Document
CCRI(II)/

09-26 CMI (Czech Republic). — Recent activities in activity measurement at the CMI, P. Dryák *et al.*, 2 pp.

09-27 MKEH (Hungary). — MKEH Progress report on radionuclide metrology, L. Szücs, 2 pp.

09-28 LNE-LNHB (France). — LNE-LNHB progress report related to radionuclide metrology, C. Bobin, 5 pp.

09-29 ENEA (Italy). — Activity report of the ENEA INMRI, M. Capogni and P. De Felice, 6 pp.

09-30 NPL (United Kingdom). — NPL Report, L.C. Johansson and P. de Lavison, 3 pp.

09-31 IRD/LNMRI (Brazil). — Report from the IRD LNMRI, C.J. da Silva, 4 pp.

09-32 BIPM. — Draft BIPM programme for radionuclide metrology for 2013 to 2016, P.J. Allisy-Roberts, 1 p.

09-33 CCRI(II) ESWG. — ESWG report to the CCRI(II), J.-M. Los Arcos, 6 pp.

09-34 CCRI(II) ESWG. — Remit of the CCR(II) Extension of the SIR working group (ESWG), J.-M. Los Arcos, 1 p.

09-35 IIK. (Austria) — IIK Research programme report, G. Winkler, 4 pp.

09-36 KRISS. (Republic of Korea) — Progress report from the KRISS, T.S. Park, 2 pp.

09-37 IAEA. (Vienna) — Report from the PCI Chemistry Unit of the IAEA laboratories, C.K. Kim, 10 pp.

09-MET Special issue of *Metrologia* on Radionuclide Metrology (44(4), 2007), 2 pp.

CONSULTATIVE COMMITTEE
FOR IONIZING RADIATION

Section III: NEUTRON MEASUREMENTS
Report of the 18th meeting
(1-3 April 2009)

Abstract

Section III (Neutron measurements) of the Consultative Committee for Ionizing Radiation (CCRI) held its 18th meeting at the BIPM headquarters, Sèvres, from 1 to 3 April 2009. In honour of the 50th anniversary of the CCRI, a special seminar entitled *"Computational dosimetry – an essential tool for neutron metrology laboratories"* was given by Gianfranco Gualdrini of the ENEA (CCRI(III)/09-23). As part of the 50 years celebration, certificates were presented to Dr André Allisy and Dr David Gilliam, and *in absentia* to Dr Randy Caswell, Dr Vic Lewis and Dr Horst Klein who could not attend the meeting. The KRISS (Republic of Korea) participated for the first time as a full member of the CCRI(III). Key comparison CCRI(III)-K10 (neutron fluence rate at 144 keV to 14.6 MeV) has been published, while key comparisons CCRI(III)-K9 (AmBe: neutron emission rate) and CCRI(III)-K1 (neutron fluence rate at 24.5 keV) and the supplementary comparison EURAMET.RI(III)-S2 (neutron fluence rate at 15.5 MeV to 19 MeV) were all at Draft B stage. Brief reports were heard from most of the participants, highlighting their written reports submitted as working documents for the meeting. Plans for a special issue of *Metrologia* were discussed.

1-5 OPENING OF THE MEETING; WELCOME / AGENDA / RAPPORTEUR

The following Members and representatives were present:

P. Cassette (LNE-LNHB), M.S. Dewey (NIST), V. Gressier (LNE-IRSN), H. Harano (NMIJ), M. Kralik (CMI), T. Matsumoto (NMIJ), N.N. Moisseev (VNIIM),R. Nolte (PTB), S. Oberstadt (IRMM), H. Park (KRISS), N. Roberts (NPL), S. Röttger (PTB), D. Thomas (Chairman, NPL), W. Walsan (LNMRI).

Observers: M. Kellett (IAEA)

Guests: A. Allisy (c/o BIPM), D. Gilliam (c/o NIST), D. Gualdrini (c/o ENEA).

Also attending the meeting from the BIPM for all or part of the time: P.J. Allisy-Roberts (Executive Secretary of the CCRI), D.T. Burns, M. Kühne (Deputy Director), L. Mussio, G. Ratel, C. Thomas (KCDB coordinator), A.J. Wallard (Director).

Apologies were received from: J. Chen (CIAE), P. De Luca (ICRU), J.M. Los Arcos (CIEMAT), H. Ye (CIAE), H. Zhang (NIM).

Section III (Neutron measurements) of the Consultative Committee for Ionizing Radiation (CCRI) held its 18th meeting at the Pavillon de Breteuil, Sèvres, from 1 to 3 April 2009. Dr M. Kühne, the recently appointed Deputy Director of the BIPM, and Dr K. Carneiro, the new President of the CCRI, welcomed the delegates to the BIPM. The President announced that all Consultative Committees have been asked to formulate strategies in order to promote metrology. The meeting noted that the CCRI celebrates its 50th anniversary in 2009.

Dr D. Thomas greeted the delegates, who then introduced themselves. Representatives of the CIAE and the NIM (China) could not be present at the meeting; however, they sent reports that were later read by Dr P. Allisy-Roberts. The CIEMAT (Spain) was also not represented. The KRISS (Republic of Korea) was warmly greeted as a first-time participant. Dr Allisy-Roberts presented a brief history of the CCRI, starting with its first meeting in April 1959. The CCRI(III)'s first meeting was held in 1972. Presentations were made to the guests of honour, Dr Allisy and Dr Gilliam; not present but receiving certificates were Dr Randy Caswell (a letter to the committee was read out), Dr Vic Lewis and Dr Horst Klein.

Dr M. Scott Dewey from the NIST was appointed as the rapporteur of the meeting.

The draft agenda was adopted without change.

6 REPORT OF THE PRESIDENT ON THE 20th MEETING OF THE CCRI, AND MATTERS ARISING FROM THE 17th MEETING OF THE CCRI(III), 2007

At the 20th meeting of the CCRI a recommendation had been made regarding key comparison CCRI(III)-K1 (neutron fluence measurements at 24.5 keV) dependant on its publication. According to this recommendation, the validity of the comparison will be accepted in support of

CMCs for an extended period until 2012, when it is expected that the comparison can be repeated as part of a new series of fluence measurements at different neutron energies. A new CCRI President, Dr Kim Carneiro, had been appointed by the CIPM. Finally the delegates were referred to the published proceedings of the 20th meeting of the CCRI and the associated section meetings.

7 CCRI(III) COMPARISONS

7.1 CCRI(III)-K10: neutron fluence rate at 144 keV to 14.6 MeV, Pilot PTB, published

Dr Allisy-Roberts discussed access to this report on the BIPM website where the refereed document appears online. Delegates were reminded that they are the referees.

7.2 CCRI(III)-K9.AmBe: neutron emission rate, Pilot NPL, Draft B report CCRI(II)/09-07

Mr N. Roberts of the NPL (UK) presented the status of this key comparison, the measurements of which took place from 1999 to 2005. All participants used the manganese bath technique, with the VNIIM (Russian Federation) also using the associated particle technique. The CMI (Czech Republic), KRISS (Republic of Korea), VNIIM and the NPL also measured the anisotropy of the source although this did not form part of the comparison. There was good agreement among these measurements. A statistical method designed at the NPL, the "largest consistent subset", was used to calculate a value for the KCRV. This technique resulted in the removal of values from the CIAE (China) and the LNE-LNHB (France). These laboratories subsequently provided new values that were in much better agreement with the group average; nevertheless, these values were not included in the calculation of the KCRV. There was good agreement among the laboratories provided that they all used the ENDF/B-VI.0 cross-sections. Mr Roberts will circulate a Draft B report for final approval, to be produced within four weeks. Once approved, the report can then be published.

7.2.1 The $^{16}O(n,\alpha)^{13}C$ cross-section problem; S. Oberstedt (IRMM)

This cross-section is important for manganese bath measurements because it represents a significant fast-neutron loss mechanism for which account must be made. For some neutron sources the correction can be several per cent. Unfortunately evaluations of this cross-section have adjusted significantly in recent years. In the case of the CCRI(III)-K9 key comparison, the problem was addressed by normalizing all the results to ENDF/B-VI.0. Dr Oberstedt discussed a recent measurement of this cross-section in the energy range 3.9 MeV to 9.0 MeV at the IRMM (Geel). Below 5.5 MeV the results were in good agreement with ENDF/B-VII.0; while between 6.3 MeV and 7.7 MeV the data reproduce ENDF/B-VI.8. There was some discussion about whether it was possible to use one cross-section below 5.5 MeV and another above 5.5 MeV in Monte Carlo N-Particle Transport Code (MCNP). This question was not resolved.

7.3 CCRI(III)-K8: thermal neutron fluence rate, Pilot PTB (Germany)

The problems with the stability of the ^{3}He counters and dead time have been resolved and this comparison has been completed by all participating laboratories except the NIST (USA) and LNE-IRSN. The NPL identified a dead time versus count rate effect, but this does not affect the final result. The NIST has declared its readiness to undertake the measurement. It will try to use a thermal beam, but if that is not possible it will use a calibrated 3.2 MeV monoenergetic beam. The LNE- IRSN reported a failure to procure ^{252}Cf sources, so more delays are expected, until perhaps 2010. In the meantime, the VNIIM would like to make additional measurements. Problems had arisen in getting this equipment to their laboratory, so it was suggested that perhaps the BIPM could facilitate this process next time. The small number of participants means that all the more effort is needed to allow the Russian group to make additional measurements.

7.4 CCRI(III)-K1: neutron fluence rate at 24.5 keV, Pilot NPL, Draft B report CCRI(III)/09-21

This comparison had finally reached the preliminary Draft B report stage. The measurements took place during 1993 to1998. While it is stipulated that comparisons should be repeated at least every ten years, the CIPM has concurred that the results of this comparison are valid until it can be repeated, around 2012. It was noted that should an NMI make a bilateral comparison of their primary standard with another NMI for this quantity, the results could be included in the database with the approval of the CCRI(III). Such approval requires that the comparison be declared in advance, that it follows an approved protocol, and that one of the NMIs already has a comparison result. In this key comparison calculating a KCRV was complicated by the existence of correlations among the results produced by each laboratory. The neutron field could be produced using any one of four techniques and in some cases laboratories used more than one. In addition there were three transfer standards. In the end only one number can be used from each participant to produce a final KCRV and also for the degrees of equivalence. The question of how to deal with correlations in the data was discussed by Dr Thomas. It appears that averaging of weighted means gives a reasonable value. Although the NPL still does not have full uncertainty budgets from some of the participants; it was decided that given that the comparison was started prior to the CIPM MRA, and the length of time that has passed those available will suffice. Dr Thomas will prepare and distribute a finalized Draft B report for approval.

7.5 Future needs for comparisons: Proposals for extending monoenergetic neutron calibrations energies, LNE- IRSN

The LNE-IRSN presented a proposition for a new fluence comparison at monoenergetic neutron fields according to which it would be the pilot laboratory for a key comparison that would be carried out at the new AMANDE facility in Cadarache (France). This would satisfy the need to renew key comparisons K1 and K10. Participants would travel to Cadarache and measure the fluence of several monoenergetic neutron beams, probably in September or October 2011. After some discussion, a preference for 27.4 keV, 565 keV, 2.500 MeV and 17 MeV emerged. It was further suggested that one reference beam per day might be measured, with one spare day, and that one laboratory need not measure all the beams. The LNE-IRSN should produce a protocol, following the example of the PTB's K10 protocol, to submit along with an invitation to the

interested parties. Interest was expressed by the PTB, LNE-IRSN, VNIIM, NMIJ (Japan), LNMRI/IRD (Brazil), IRMM and the NIST. The NMIJ raised the question of 8 MeV, a beam energy that is sometimes requested of several laboratories, discussion of which was deferred until the next CCRI(III) meeting.

8 RMO COMPARISONS

8.1 EURAMET.RI(III)-S1: comparison of neutron survey meter calibrations, EURAMET-project #608, Pilot LNE-IRSN

The first part of this comparison which was started in 2005 is complete, with the participation of six laboratories. Others had been interested but it was impossible to continue the comparison due to the breakage of a transfer instrument. In the meantime, a report including absolute rather than relative results was circulated to the six participants. It was proposed that a Draft B report should be prepared for the results obtained to date which would then complete the S1 comparison. However, China, the United Kingdom, Germany, the Russian Federation and Japan expressed interest in participating in a continuation of this comparison. In order to do so a pilot laboratory will be needed as the LNE-IRSN is unable to pilot next time. In addition, a new transfer instrument is needed, and a schedule needs to be established. One or preferably two laboratories should act as a link to the earlier results by repeating the same measurements with the new instrument. In this case, the comparison can continue and the new measurements would be identified as EURAMET.RI(III)-S1.1 to indicate they are linked to S1. The BIPM offered to help ship the new instrument to the various laboratories, as transferring instruments around the world is proving so difficult, and the CMI offered to be the linking laboratory. There was some discussion about the new transfer instrument. The VNIIM may be able to repair the old one. Dr Thomas will initiate questions concerning a new transfer instrument and explore the involvement of other countries as Brazil, for example, has expressed interest. A suggestion to make this a CCRI comparison was vetoed. No writer for the final report was identified, although the BIPM offered to be the intermediate repository for the laboratory reports.

8.2 EURAMET.RI(III)-S2: neutron fluence rate at 15.5 MeV to 19 MeV, project #822, Pilot PTB, Draft B report CCRI(III)/09-13

A Draft B report has been prepared for this comparison. There were special experimental issues, but the final results look good and the uncertainty budgets are realistic. Two conclusions were that the NPL long counter could be used in non-monoenergetic fields and a determination of Φ_E using time of flight spectrometry was important. The Draft B report has to be approved by EURAMET and then sent to Dr Allisy-Roberts at the BIPM.

8.3 EURAMET: Comparison of long counter measurements of monoenergetic neutron fluence, EURAMET-project #936, Pilot NPL

This comparison was under way. The LNE-IRSN, NPL and PTB want to improve their understanding of the response characteristics of the long counters.

8.4 Other planned RMO comparisons

The INFN (Italy), LNE-IRSN, PTB, NPL, UAB (Spain) are planning to make spectral measurements of ISO-recommended radionuclide sources for neutron calibrations (^{252}Cf, D_2O moderated ^{252}Cf, ^{241}AmBe, ^{241}AmB). There are three ISO standards that govern the use of these sources and they are due for revision. The INFN is the prime mover in this work, however the pilot laboratory must be an NMI or designated institute. This issue has not yet been resolved.

8.5 Future needs (RMO key or supplementary comparisons)

There was discussion of a new supplementary comparison of the calibration of electronic dosimeters in the field of radionuclide neutron sources, focusing on which sources and dosimeters would be used. The EPD-N2, DMC2000, and Saphydose-n were suggested as possibilities. There seemed to be a preference for circulating one or two electronic dosimeters among the participating laboratories. They would then make measurements of standard sources. At least eight members were interested in such a comparison. Brazil is considering being the pilot laboratory with the BIPM assisting with instrument transportation and regular QA between the laboratories' measurements. As this comparison would be worldwide and no RMO was keen to adopt it as an RMO comparison, it should be registered as a CCRI supplementary comparison.

9 EXCHANGE OF INFORMATION ON NEUTRON METROLOGY IN PROGRESS AT PARTICIPANTS' LABORATORIES, PART I

Dr Carneiro launched this item with some thoughts about strategies for the CCRI that had been developed during a CIPM seminar in 2008, addressing the questions "Where would we like to be in 10 to 15 years?", "How will we get there?", and "How will we share the work between BIPM and NMIs?" One weakness identified was the length of time taken to finish key comparisons: sometimes they are finished too late to be useful. It was suggested that the BIPM could assist with piloting, particularly if Member States would share the cost of a dedicated assistant at the BIPM. The CCRI would produce a draft strategy document in June 2009. Sections I, II and III would be asked for comments. The CCRI President will present a plan to the CIPM in October. Comments were to be sent by June 2009 to Dr Allisy-Roberts or Dr Thomas.

9.1 NIM (Z. Hui) – CCRI(III)/09-02

Dr Allisy-Roberts projected Dr Hui's slides. The NIM has rebuilt its reference neutron irradiation field facility and plans to replace the Ra-Be primary source with a new Am-Be source. It is commissioning a new Mn bath system, and has carried out many routine calibrations of neutron survey meters. The laboratory would like to take part in more international comparisons. In particular, if the NPL could supply a measured neutron source they could measure its emission rate and be added to key comparison K9. Dr Allisy-Roberts will write to the NIM to gauge interest in measuring a 37 GBq (one curie) Am-Be source. The question of identifying the reference position in meters was raised in the context of neutron ambient dose equivalent measurements. It was suggested by the CCRI(III) that spherical systems are best, because the centre of the sphere is the reference position; otherwise the manufacturer's recommendation should be followed.

9.2 IRMM (S. Oberstedt) – CCRI(III)/09-03

The JRC-IRMM was in the process of replacing an accelerator operator and a neutron metrologist. The neutron group is currently engaged in mapping neutron fields, fully characterizing a NE213 liquid scintillator with neutrons, and measuring neutron backgrounds.

9.3 CMI (M. Kralik) – CCRI(III)09-04

Dr Kralik focused his comments on the CMI's work with low resolution neutron spectroscopy using Bonner sphere spectrometers, which are used to characterize neutron fields at various working sites. The group has characterized the neutron fields produced by a shielded Pu-Be source at the Bulgarian Institute of Metrology and a shielded Am-Be source at the Hungarian Paks Nuclear Power Plant. In certain pulsed neutron fields where overloading can lead to problems with active detectors, track detectors or TLD pairs (^{6}LiF and ^{7}LiF) were used. Track detectors were used for the spectral measurement of photo-neutrons around a radiotherapeutic linear accelerator and TLDs were used to measure (d,d) neutrons near a plasma focus device (PF 1000, Institute of Plasma Physics and Laser Microfusion, Warsaw).

9.4 NIST (M. Scott Dewey) – CCRI(III)/09-05

Dr Scott Dewey discussed several projects which were under way in the Neutron Interactions and Dosimetry group at the NIST. A small ("mini") Mn bath is being commissioned to calibrate weak ^{252}Cf sources such as Homeland Security sources and the sources intended to calibrate neutron detectors in certain neutrino experiments. An attempt will be made to use the mini-bath to recalibrate NBS-I, the NIST primary Ra-Be (γ,n) neutron standard. Two additional projects are related to this recalibration: measuring the fluence rate of a cold monochromatic neutron beam to 0.1% or better relative uncertainty, and calibrating a weak bare ^{252}Cf source via knowledge of ν-bar and its observed fission rate. Finally, work is continuing on two fast neutron spectrometers that will use a ^{6}Li-loaded liquid scintillator. Detecting recoil gamma-rays in coincidence with ^{6}Li capture events will lead to low backgrounds. One spectrometer will be

large and have a high efficiency, while the other will be small, leading to lower efficiency, and segmented, permitting a more precise determination of neutron energy.

9.5 LNE-IRSN (V. Gressier) – CCRI(III)/09-08

The IRSN has added a ^{137}Cs photon source to its collection of radionuclide sources. Unfortunately the thermal neutron source facility is unavailable because of the failure to procure a ^{252}Cf source for it. Hopefully a source will be available around 2011. This would allow the laboratory to participate in the CCRI(III)-K8 key comparison. Much of its work has focused on the AMANDE facility. A long-counter to measure neutron fluence references has been constructed and calibrated. Time of flight measurements to measure monoenergetic beam energies (E_n > 1 MeV) have been carried out. Detailed modelling of the LNE-IRSN experimental hall geometry has been undertaken in order to take into account scattered neutrons when experimental subtraction is not possible. Studies were being made of the ^{45}Sc(p,n) reaction as a way to produce low energy neutron beams (down to 8 keV), and of two novel recoil nuclei detectors in order to measure the absolute neutron energy distribution. The LNE-IRSN continues to study issues associated with the characterization of high energy neutron fields, because many of their clients are interested in this. Quality control was being established for calibrations at the AMANDE facility according to the ISO-17025 standard.

9.6 LNE-LNHB (P. Cassette) – CCRI(III)/09-39

Dr Cassette spoke about the new Mn bath facility which should be finished at the end of 2009. It will include the unique feature that it will measure directly and online the ^{56}Mn activity per unit of mass by measuring Cerenkov and gamma radiation in coincidence. A Ph.D. student is required to assist with this work.

10 CIPM MRA

10.1 CCRI RMO CMC Working Group report (2007) CCRI(III)/09-20

Dr Luis Mussio, Executive Secretary of the JCRB, led this discussion. There are currently fifty-two Member States of the BIPM and twenty-six Associates of the CGPM. Some new regulations have been drawn up concerning RMOs, CMCs, NMIs and the JCRB. The CMC definition has been modified. In March 2009, the JCRB introduced a system of annual reports from NMIs in which the NMIs are to report any changes that may affect their CMCs. The AFRIMETS is an expansion of the existing RMO SADCMET. World Metrology Day is to be 20 May 2009.

There was a lengthy discussion about CMCs that are coming up for review and how to ensure that they are adequately supported by comparisons. The CCRI(III) felt that as the expertise in this field was concentrated in themselves, the review of neutron CMCs would be best achieved

within the CCRI(III) framework. The CCRI RMO Working Group meeting for ionizing radiation CMCs was scheduled for June 2009. One issue they will discuss will be whether to use $k = 2$ with 95% confidence for the expanded uncertainty.

10.2 RMO activities: AFRIMETS (CCRI(III)/09-17); APMP (CCRI(III)/09-11); COOMET (CCRI(III)/09-20); EURAMET (CCRI(III)/09-14); SIM (CCRI(III)/09-15)

It was noted that the AFRIMETS is an expansion of the existing RMO SADCMET. As there were no specific presentations, the CCRI(III) delegates were directed to the CCRI(III) 18th meeting section of the BIPM website for these RMO reports. Dr Allisy-Roberts mentioned that it had been difficult to establish reliable contact in India to identify their eventual involvement in neutron metrology. The BIPM was currently negotiating to bring in partners from the Middle East within a new RMO.

10.3 BIPM-KCDB: Appendix C submissions (neutron CMCs, approved and under review)

After some discussion on the requirement to review all neutron CMCs, it was decided that a one-day meeting immediately prior to the next CCRI(III) meeting should be held to make a formal review of neutron CMCs, as the CCRI RMO Working Group cannot be expected to have the expertise of the CCRI(III).

11 SPECIAL ISSUE OF *METROLOGIA* – PROGRESS REPORT FROM GUEST EDITORS ON PROPOSED CONTENT AND AUTHORS

Dr Thomas had prepared a working document on the *Metrologia* special issue for the delegates to read before the meeting (CCRI(III)/09-18), which was used as a starting point for discussion. Each section should be a stand-alone paper rather than a chapter, and some ten papers of about sixteen pages are expected. Each section will have a lead author responsible for producing the article, assisted by the other authors. It was noted that these experts need not be members the CCRI(III). First drafts are requested by the end of 2009, and it is expected that the special issue will be published in 2010. Two topics were suggested in addition to the seven identified by Dr Thomas: “High energy” and “Monte Carlo”. There was a call for more authors from outside the United States and Europe. Dr Gilliam of the NIST agreed to lead the section on thermal neutron standards. Dr Allisy-Roberts suggested that “Monoenergetic neutron standards” might merit two sections (E < 20 MeV and E > 20 MeV). Dr Gilliam proposed the NIST’s Dr Allan Carlson for the section on cross-section measurement standards. The delegates were satisfied with this and Dr Gilliam agreed to ask Dr Carlson if he would be willing to lead this section. The IRMM will also contribute to this section, and Dr Mark Kellett from the IAEA believes that Dr Vladimir Pronyaev could also contribute. Three further presentations on the BIPM website include confidential comments on various sections of the special issue: CCRI(III)/09-43 on “Review of Neutron Metrology”; CCRI(III)/09-44 on “Neutron Source Emission Rate Measurements”; and CCRI(III)/09-45 on “Monoenergetic Neutron Standards”.

12 EXCHANGE OF INFORMATION ON NEUTRON METROLOGY IN PROGRESS AT PARTICIPANTS' LABORATORIES, PART 2

12.1 CIAE (J. Chen) – CCRI(III)/09-06

Dr Allisy-Roberts presented Dr Chen's slides. The CIAE group has made upgrades to its 5SDH-2 tandem accelerator facility. It now has a pulsed beam that allows for time of flight neutron energy measurements, and a new TORVIS gas source. In addition there are new detectors to characterize neutron beams; a BC501A liquid scintillation detector, a ^{3}He grid ionization chamber, and a tissue equivalent proportional counter. A 25.5 MeV neutron calibration field has also been established at the HI-13 tandem accelerator. Plans were under way to develop a monoenergetic neutron calibration field in the keV range using the ^{45}Sc(p,n) reaction and to develop a calibration field that simulates the neutron energy spectra of the workplace of a pressure water reactor.

12.2 NPL (D. Thomas) – CCRI(III)/09-09

Mr Roberts gave this presentation of the work in progress at the NPL. He described the NPL's new operational Mn bath facility. A series of measurements has been performed to characterize the new facility with regard to detection efficiency, solution concentration, impurities and effective flow rate. These showed only very minor changes from the old facility. Maintenance of the forty-year-old Van de Graaf which is used to produce neutrons has been an issue. Problems in December 2008 implied that the tube and belt needed to be replaced. It is becoming difficult to find certain spare parts. The thermal pile is much in demand as there are now no research reactors left in the UK. There was a lengthy discussion concerning phantoms and variations of dose across their surfaces due to distance variation, fluence to personal dose equivalent conversion coefficient variation, and energy variation. These effects have been modelled and quantified.

12.3 NMIJ (H. Harano) – CCRI(III)/09-10

Three monoenergetic neutron fluence standards have been developed (2.5 MeV, 8.0 MeV, 24 keV) at the NMIJ, and calibration services have begun. Work was under way to develop a 19 MeV monoenergetic neutron fluence standard. Source-emitted neutron fluence standards for ^{252}Cf and ^{241}Am-Be have been extended so that calibrations are also available in terms of ambient and personal dose equivalent. Monoenergetic neutron fluence and source-emitted neutron fluence calibration services are now performed within the context of the Japan Calibration Service System. The 2nd CIPM peer review was carried out in October 2008 and ISO/IEC 17025 accreditation was updated in March 2009. Data analysis of measurements in the CCRI(III)-K8 comparison was in its final stage. A new thermal neutron calibration field using a thermal neutron guided beam was being developed at the research reactor JRR-3M of the JAEA, and a high-energy (20 MeV to 100 MeV) neutron standard field was being established in collaboration with Tohoku University, KEK and JAEA.

12.4 PTB (R. Nolte) – CCRI(III)/09-12

The PTB does not have an absolute method for realization of neutron fluence above around 1.2 MeV due to the ageing of its recoil proton telescope radiators. Instead it must rely on comparisons with the recoil proton proportional counter and their D1 detector which is a NE213 scintillation detector. In future, the de Phanger long-counter will be included in regular internal consistency checks. Work has continued on a realistic calibration field aided by a researcher working towards a diploma thesis. A thick water-cooled lithium target is used inside a moderator sphere made from graphite and polyethylene. The PTB's work with high-energy neutrons in South Africa will be significantly reduced by the end of 2009; therefore it is attempting to transfer skills and some equipment to South African colleagues. In Germany, the FRG1 reactor will cease to function by the end of 2010, and thus there is a need for a new thermal reference field at one of the German research reactors. Within the EFNUDAT project, the group participated in the characterization of two upcoming neutron beam facilities. In the case of the high-energy white beam facility ANITA at the Svedberg Institute in Uppsala, the measurement was especially challenging. The neutron spectrum above 10 MeV was inferred from several measurements using an analytical model for the spectral shape. The parameters of the model and their uncertainties were determined from the data set using the WinBUGS software, which employs the Markov chain Monte Carlo method for parameter estimation. The PTB was also planning to replace the ageing 3.7 MV Van de Graaf accelerator with a state-of-the-art tandem accelerator, because of expected future difficulties in the procurement of replacement parts for the Van de Graaf as well as problems relating to the operation of the present accelerator in pulsed mode.

12.5 KRISS (H. Park) – CCRI(III)/09-16

The KRISS has developed an extended Bonner sphere system in order to extend the energy range for neutron spectrometry. The response matrix has been calculated using MCNPx. The system was used in a neutron spectrum measurement at a nuclear power plant in Korea. The neutron group has also designed and produced a long counter for neutron fluence measurements, whose response function and effective centre have been calculated. A calibration measurement to determine its efficiency and effective centre will be performed later in 2009. This system will be used to measure the neutron spectrum at ground level at the KRISS and to measure the neutron spectrum in an underground laboratory for ultra-low background. A liquid scintillation counter system was being built for high-resolution neutron spectrometry.

12.6 VNIIM (N. Moiseev) – CCRI(III)/09-19

The VNIIM has used a graphite ball to measure neutron emission rate without the need for calibration. It has created and investigated a beam-like thermal neutron field to be used for key comparison K8. A transportable device to compare neutron source strengths has been built, and various neutron devices have been investigated with a view to using one as a comparison instrument in a future COOMET comparison. All this has been carried out in addition to normal duties.

12.7 LNMRI/IRD (W. W. Pereira) – CCRI(III)/09-22

During the past year the LNMRI/IRD has upgraded its neutron facilities. Work was expected to be complete by June 2009. The group has been pursuing collaboration with the NIST concerning the Mn bath and other systems. The next SIM meeting will be held at LNMRI/IRD this year. New CMCs were planned for future submission, and work has progressed towards the quality system. A peer review will take place in May 2009.

13 INTERNATIONAL ORGANIZATIONS

13.1 ICRU

The delegates discussed ICRU operational quantities, which are important in the context of medical health physics. With the recent changes to the ICRP organ weights and potential organ sensitivities, the various ICRU conversion factors are undergoing revision, which will include neutron dosimetry in particular. Concerns were raised about these issues with the hope that the ICRU would consider the effects of the changes on the neutron metrology community.

Above 150 MeV it was noted that there is very little cross-section information and cross-sections are estimated from nuclear models. Occasional comparisons by various transport codes give different results in the range 150 MeV to 350 MeV. In this energy range only LANCE WNR can actually measure cross-sections. To avoid a compromise it was suggested that the CCRI(III) might recommend an international collaboration to advance this work; perhaps within the framework of EURADOS.

Lead authors were committed to their tasks and first drafts requested by the end of 2009, in the expectation that the issue will be published in 2010.

The CCRI(III) noted that applications of high energy particle therapy would greatly benefit from a microdosimetric approach to secondary neutron determinations, as little work had been published in this field.

13.2 IAEA (M. Kellett)

Dr Kellett from the IAEA Nuclear Data Section spoke about recent activities and distributed updated links for websites. There was an urgent European call for ENSDF evaluators. The CCRI(III) should encourage colleagues to participate. It was noted that the FENDL-3.0 CRP (Fusion Devices) had just been launched.

14 PRESENT AND FUTURE MEMBERSHIP OF THE CCRI(III)

Several countries having neutron CMCs but no CCRI(III) membership were noted: Australia (two), Canada (one), Italy (nine), Slovakia (nine). It was suggested that an official letter be sent to invite their NMIs to the next meeting of the CCRI(III). India could also be invited. It was noted that current Observers include the CIEMAT, CIAE, IAEA and ICRU. It was stated that application must be made to the BIPM Director for an NMI to become an Observer or a Member of the CCRI(III).

15 WORK PROGRAMME OF THE BIPM IONIZING RADIATION SECTION (FOR INFORMATION)

It was suggested that the CCRI(III) might wish the BIPM to conduct a neutron workshop on its behalf during the period 2009 to 2012; perhaps linked with the launch of the special issue of *Metrologia*, and with the IAEA or IRMM in partnership to widen the scope for invitations. There is some fear that expertise is disappearing in the neutron measurement field.

16 CCRI(III) WORKING DOCUMENT STATUS

The selection of Working Documents for open publication was identified and delegates were reminded that Draft B reports are never open as these are pre-publication.

17 OTHER BUSINESS

There was some discussion of the status of the IRMM neutron programme which is of particular concern to the PTB. The IRMM sample preparation programme in particular could be at risk of closure and yet the PTB was having difficulty in obtaining the necessary uranium samples. The BIPM Director was encouraged to send a letter of strong support to the IRMM regarding sample preparation as the IRMM was in need of external requests to keep certain programmes operating.

18 DATE OF THE NEXT MEETING

Although the CIPM will finalize the dates, Dr Allisy-Roberts recommended that different months for the three CCRI sections be chosen as had occurred this time. April 2011 was an obvious choice for the CCRI(III) although the order of the three meetings could be switched. The Chairman closed by thanking the BIPM and Dr Allisy-Roberts for her efforts towards making this meeting a success and the delegates were thanked for all their input.

APPENDIX R(III) 1.
Working documents submitted to the CCRI(III) for its 18th meeting

Open working documents of the CCRI(III) 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=CCRI(III)

Documents restricted to Committee members can be accessed on the restricted website.

Document CCRI(III)/	
09-00	Draft agenda, 2 pp.
09-01	CIPM. — CCRI report 2007 to the CIPM, G. Moscati, 6 pp.
09-02	NIM (P.R. China). — Recent activities in neutron metrology at the NIM, Z. Hui, 4 pp.
09-03	IRMM (Geel). — Recent developments in neutron measurements at the EC-JRC-IRMM, S. Oberstedt, 8 pp.
09-04	CMI (Czech Rep.). — Progress report on the neutron metrology and dosimetry at the CMI, M. Králik, 3 pp.
09-05	NIST (United States). — Report of the NIST to the CCRI(III), L.R. Karam and M.S. Dewey, 39 pp.
09-06	CIAE (P.R. China). — Neutron metrology activities at the CIAE from 2007 to 2008, J. Chen, 7 pp.
09-07	CCRI(III). — Draft B report of CCRI(III)-K9 for approval, Z. Wang *et al.*, 37 pp.
09-08	IRSN (France). — Recent developments in neutron metrology at the IRSN, A. Allaoua *et al.*, 14 pp.
09-09	NPL (United Kingdom). — Recent developments in neutron metrology at the NPL, N. Roberts *et al.*, 16 pp.
09-10	NMIJ/AIST (Japan). — Recent activities in neutron standardization at the NMIJ/AIST, H. Harano *et al.*, 7 pp.
09-11	APMP. — APMP/TCRI Activity Summary, Y. Hino and M.-C. Yuan, 4 pp.
09-12	PTB (Germany). — Recent developments in neutron metrology, neutron dosimetry and related areas at the PTB, R. Nolte, 3 pp.
09-13	EURAMET. — EURAMET Report Project 822 Comparison of Neutron Fluence Measurements above 14 MeV, G. Lövestam *et al.*, 31 pp.
09-14	EURAMET. — EURAMET activities in the field of neutron measurements, M. Králik *et al.*, 6 pp.
09-15	SIM. — Report of the SIM laboratories to the CCRI(III), L.R. Karam and M.S. Dewey, 9 pp.

Document
CCRI(III)/

09-16 KRISS (Rep. of Korea). — Report of the KRISS, H. Park, 4 pp.
09-17 AFRIMETS. — AFRIMETS Report to the CCRI, Z. Msimang, 2 pp.
09-18 CCRI(III). — *Metrologia* special edition, D. Thomas, 3 pp.
09-19 VNIIM (Russia). — Recent Activity of VNIIM Neutron Group, N.N. Moiseev, 3 pp.
09-20 COOMET. — COOMET activity in neutron measurements, N.N. Moiseev, 2 pp.
09-21 CCRI(III). — Preliminary draft B report for the CCRI(III)-K1 24.5 keV neutron fluence comparison, D.J. Thomas *et al.*, 35 pp.
09-22 LNMRI/IRD (Brazil). — Progress report from the LNMRI , W.W. Pereira, 3 pp.