Bureau International des Poids et Mesures

Consultative Committee for Ionizing Radiation (CCRI)

Report of the 20th meeting
(31 May 2007)
to the International Committee for Weights and Measures

Comité international des poids et mesures

Note:

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

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

A.J. Wallard
Director BIPM

LIST OF MEMBERS OF THE CONSULTATIVE COMMITTEE FOR IONIZING RADIATION

as of 31 May 2007

President

G. Moscati, member of the International Committee for Weights and Measures; Instituto de Fisica, Universidade de São Paulo, São Paulo.

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.

Nederlands Meetinstituut, Van Swinden Laboratorium [NMi 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 Ionising 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 Ionising 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 Office of Measures/Országos Mérésügyi Hivatal [OMH], Budapest.

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.

Nederlands Meetinstituut, Van Swinden Laboratorium [NMi 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.

National Institute of Metrology [NIM], Beijing.

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

National Laboratory for Metrology of Ionising 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 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 20th Meeting
(31 May 2007)

to the International Committee
for Weights and Measures

1 OPENING OF THE MEETING

The 20th meeting of the Consultative Committee for Ionizing Radiation (CCRI)* was held at the Pavillon de Breteuil (the BIPM headquarters), in Sèvres, on 31 May 2007.

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

Also in attendance were: P.J. Allisy-Roberts (Executive Secretary of the CCRI) and D.T. Burns (BIPM).

In his introduction, Prof. Moscati thanked all present for their contributions to the Section meetings and noted an improved functioning of these meetings. He commented that on occasions the language barrier prevented certain members from contributing fully, a problem that Prof. Wallard added was common to many Consultative Committee (CC) meetings. Prof. Moscati was encouraged that the benefits of the CIPM MRA were becoming more apparent, not only in the visibility of the work of the BIPM and the CCs, but also in the improved quality of comparisons.

2 APPOINTMENT OF RAPPORTEUR

Dr Burns was appointed *rapporteur*.

3 REPORT OF THE 19TH MEETING OF THE CCRI, 2005**

Prof. Moscati noted the minutes of the meeting and, having presented the minutes at each Section meeting, he had no further comments to make. There were no further comments from the present participants.

---

* For the list of acronyms, click here.

** Documents for the meeting which are open access (underlined) are available on the BIPM website.

4 CONCLUSIONS OF THE MEETINGS OF THE THREE SECTIONS OF THE CCRI

Prof. Moscati invited each Chairman in turn to report on their Section meeting.

4.1 **Section I** (Chairman: P. Sharpe)

Dr Sharpe noted a successful meeting and highlighted a number of important points.

4.1.1 LNE-LNHB/BIPM Dosimetry Workshop

The three-day Workshop on Air Kerma and Absorbed Dose Standards, which preceded the Section I meeting, was extremely successful, with over fifty participants and a wide range of interesting papers providing a very useful input to the Section I meeting. A set of twenty recommendations was made to Section I, the majority of which were accepted, some after amendment. A similar Workshop on Brachytherapy is proposed to coincide with the next Section I meeting. Dr Sharpe noted, however, that this arrangement draws heavily on the BIPM resources and wondered if the logistics could be altered to lighten the burden. One suggestion was to appoint a *rapporteur* for the Workshop to present the recommendations on the second day of the Section I meeting.

4.1.2 *W* value for air

Data presented at the Workshop and to Section I suggest a change to the *W* value for air and to the electron stopping power of graphite. This is a complex matter, *W* and the stopping power ratio of graphite to air being correlated. An ICRU Report Committee is studying this problem and Dr Burns noted that this Committee had met twice recently. Laboratories were encouraged to forward any relevant data to the ICRU.

4.1.3 Change to the BIPM air-kerma standard

The change proposed at the Section I meeting in 2005 was discussed in relation to new work at the BIPM using a variable-volume chamber that has consequences for the volume determination of the primary standard. Section I decided that the time was right to make a combined change to the BIPM standard, despite some uncertainty in the interpretation of the results of the volume determination, and agreed to the value and uncertainty proposed by the BIPM. The BIPM agreed to publish in the open literature the results for the variable-volume chamber, with a view to adoption of the change at the earliest opportunity. No recourse to Section I was deemed necessary. In the meantime, the outstanding reports for air-kerma comparisons could be published.

4.1.4 Regional comparisons

Dr Sharpe commented on the usefulness of the BIPM report presented to Section I giving guidance on the analysis of the results of regional comparisons and looked forward to the

analysis programme currently in preparation. It was clear at the Section I meeting that there was a need for such guidance.

The proposal by the NIST for a new high-dose comparison was accepted. The degree to which the BIPM would be involved, particularly in relation to irradiations, would be clearer when a draft protocol was available.

4.1.5 Brachytherapy

Dr Sharpe noted the development of graphite and water calorimeters for brachytherapy dosimetry presented at the Workshop, the involvement of the BIPM in planned brachytherapy comparisons and the plea made by Dr Allisy at the Workshop for a secondment from an NMI to assist in this work at the BIPM.

4.1.6 Proton dosimetry

A very interesting seminar on compact proton accelerators was given by Dr G. Caporaso at the Section I meeting, although there was some suggestion that the four-year time-scale to realization might be optimistic. This raised the question of a change of name for Section I to reflect the fact that proton dosimetry is included in the work of the Section. It was formally agreed by the CCRI that the new name "x- and γ-rays, charged particles" be proposed to the CIPM (See Recommendation R 1(2007)).

4.1.7 New trends in dosimetry

Dr Sharpe noted the presentation of EURAMET roadmaps looking ahead fifteen years, with developments related to novel radiation sources and treatments, nano-dosimetry and the possible need for new quantities. Other presentations at the Workshop discussed new temperature measurement systems, data analysis techniques, small fields and 3D-dosimetry. The increasing number of accelerators at national laboratories highlighted the need for the BIPM to be involved in comparisons at these energies, ideally through the installation of an accelerator at the BIPM.

4.1.8 Publications

A schedule for publication of a special issue of *Metrologia* on dosimetry was presented, aiming at publication in the second half of 2008. Dr Sharpe noted the impressive demonstration of the new BIPM search engine to Section I, made by Dr C. Thomas, and the request that old reports be made available electronically. This arose during the discussion of recent work on the air-density correction for ionization chambers, noting effects that were uncovered many years ago in a report to Section I.

4.1.9 Membership of Section I and its Working Groups

It was noted at Section I that the GUM appeared to be inactive and it was agreed that Dr Allisy would contact them to find out if they wished to remain a Member. The IAEA, in contrast, were noted to be very active and were encouraged to apply for membership. The membership of the Key Comparisons Working Group (KCWG(I)) was revised, with Dr Sharpe taking the

chairmanship and Dr Aalbers of the NMi (now retired) a Corresponding Member. The Working Group on Air-kerma Correction Factors for Cavity Chambers was disbanded.

Finally, Dr Sharpe noted the strong support of Section I for the work programme at the BIPM, and also the support for an accelerator at the BIPM. In this respect, Prof. Moscati expressed the formal CCRI acknowledgement of the importance of a high-energy facility at the BIPM and the endorsement of the CCRI for the BIPM to enter the high-energy field at the earliest opportunity.

4.2 **Section II** (Chairman: B.R.S. Simpson)

Dr Simpson summarized the meeting of Section II, which focused on activity comparisons and the future work programme.

4.2.1 Activity comparison programmes

Dr Simpson presented data for the number of ampoules submitted to the SIR and noted that the BIPM Quality System had been extended to include the SIR, which had involved the writing of twenty-three procedures and technical instructions. The new data acquisition system for the SIR had been run in parallel for 18 months. Twelve comparison reports were published over the past two years. Key comparison reference values (KCRVs) were derived from unweighted means and seven KCRVs had been updated since 2005. A call was made for SIR submissions for those radionuclides with large uncertainties, or few entries, or where the KCRV was either not defined or had been obtained from the new mathematical measurement model for SIR efficiency curve.

The KCWG(II) met three times in the past two years and had appointed a new Chairperson. An important outcome was the generation of a generic groupings table, categorizing 152 radionuclides according to appropriate measurement methods, with the level of difficulty of measurement being colour-coded. This is an active and evolving document. A resolution was adopted whereby any change to the table that could have an impact on the supporting evidence for Calibration and Measurement Capabilities (CMCs) would be made known to affected laboratories one month in advance of the change.

The ^{55}Fe comparison was completed, the recently distributed Draft A report showing the BIPM result to be an outlier. The ^{99}Tc^{m} comparison is planned as an ongoing exercise, ^{85}Kr gas is scheduled for 2007 and ^{3}H re-scheduled for late 2008. Instead, ^{177}Lu will form the object of a comparison in 2008; consequently, ^{35}S is moved back in the programme to 2009 and ^{131}Cs to 2011.

Progress on Regional Metrology Organization (RMO) comparisons was presented to Section II: EURAMET (the former EUROMET) ^{237}Np, APMP ^{134}Cs and ^{133}Ba, and COOMET ^{241}Am. Comparisons being planned are APMP ^{131}I and ^{14}C, and COOMET ^{137}Cs. Progress on supplementary comparisons of Standard Reference Materials was also presented.

A table was presented at Section II showing the 21 radionuclides whose comparisons are reaching the end of their validity under the CIPM MRA 20-year rule. The issue of using common values for the radionuclide decay parameters was also discussed with the benefits of using the *BIPM Monographie 5* being highlighted.

4.2.2 Working Groups

The coordinator of the Uncertainties Working Group (UCWG(II)), Dr H.Janßen (PTB), announced his retirement and was thanked for his important contributions. Dr M. Unterweger (NIST) was appointed to replace him. The proposed Uncertainties Workshop will be held mid-2008 in conjunction with a Comparisons Workshop. Practical exercises will be prepared to identify problem areas.

The Working Group on the Extension of the SIR to β-emitters using Liquid Scintillation (ESWG(II)) met twice. The CIEMAT presented results showing good stability for the proposed scintillator XAN6040, but other laboratories including the BIPM could not replicate this stability. An alternative scintillator recipe developed by the NMISA and the LNE-LNHB is still under study. Two operational schemes for comparing submitted samples were presented and it was proposed that interested laboratories send samples of ^{90}Sr of known activity to the ESWG(II) later this year.

Progress on the realization of the becquerel using a reproducible ion chamber design was reported, the Working Group on the Realization of the Becquerel (BqWG(II)) having met just prior to Section II. Various technical details need to be addressed over the next year with the final production taking two to three years.

Progress was also presented on the Transfer Instrument Working Group (TIWG(II)) set up to provide a comparison system for short-lived radionuclides. The system, comprising a well-type NaI(Tl) detector, a ^{93}Nb^{m}/^{94}Nb check-source and counting electronics, has been tested using ^{99}Tc^{m} and further testing using ^{99}Mo is planned for the impurity content in ^{99}Tc^{m}.

The coordinator and sole member of the Working Group on High-efficiency Detection Systems was unable to attend the Section II meeting, but explained the delays due to other commitments. Dr Allisy agreed to encourage Prof. Winkler in this work and Dr F. Maringer from the BEV volunteered to co-author if appropriate.

The WG coordinators were reminded of the need to prepare a report for the CCRI.

4.2.3 BIPM programme

The members of Section II were satisfied with the current and future BIPM programmes, although some concern was expressed over the time taken to get the extension of the SIR to β-emitters operational. A possible solution to the delay in calibrating the HPGe detector was to have a secondment from an NMI to the BIPM for three to six months. The BqWG(II) is looking for a new supplier of ampoules for the SIR.

4.2.4 *Metrologia* special issue

Section II was on track for publication of a special issue of *Metrologia* on radionuclide metrology scheduled around August 2007 with nine out of nineteen papers already accepted by *Metrologia*, the remaining being with the author or a referee. The issue will comprise three sections: (i) implementation of the CIPM MRA in radionuclide metrology, (ii) the 'state-of-the-art' (the largest section) and (iii) traceability.

4.2.5 Section II membership

The request by the BEV for Observer status of Section II was supported at the Section meeting, following the presentation of the BEV facilities and equipment by Dr Maringer.

4.3 **Section III** (Chairman: D. Thomas)

Dr Thomas was pleased with the number of NMIs (eleven) present at the Section III meeting and presented the highlights of the meeting.

4.3.1 Section III membership

The KRISS, which had applied for membership in 2005, had demonstrated its level of commitment by involvement in two comparisons and Section III was now ready to support the application from the KRISS for full membership. Prof. Moscati would propose this to the CIPM. In addition, the CIEMAT presented their plans for a neutron facility and were encouraged to apply for Observer status.

4.3.2 Key comparisons

A Draft B report was now available for the comparison for mono-energetic neutrons. This work was carried out at the PTB in 2000 and, although the measurements were relatively quick, the analysis was complicated and agreement was slow to be achieved. Nevertheless, this Draft B was an important step forward and it was agreed to move to publication.

A Draft A report was presented for the comparison of neutron emission-rate measurements, carried out by circulating a radioactive source. Of the eight results, two appeared to be outliers. Transport difficulties were highlighted, especially regarding China, although these were mainly due to security issues rather than difficulties with customs. An unexpected outcome from this comparison was a problem related to newly published cross-sections, highlighting the fact that new evaluations appeared to be less appropriate than previous values.

A key comparison of thermal neutron fluence rate measurements was in progress and running well.

The earlier comparison of neutron fluence rates at 24.5 keV was discussed. This work was carried out between 1993 and 1996 and, despite good results, the evaluator (now retired) had questioned certain aspects and further work had been required. Despite some reservations regarding the validity of these results for the standards disseminated today, Section III decided to draw a line at this stage and to write the comparison report as the data stand.

This prompted a recommendation to the CIPM, for consideration by the CCRI, that the period of validity for this comparison be extended from ten years to fifteen years. A slightly modified version of the recommendation was agreed by the CCRI for transmission to the CIPM (See Recommendation R 2 (2007)).

4.3.3 CIPM MRA

Dr Thomas noted that the RMOs appeared to have no outstanding issues with neutron CMCs. One remark made at Section III indicated that there was very little discussion of neutron issues at the annual meeting of EUROMET Contact Persons for dosimetry.

4.3.4 Future needs

Dr Klein, the previous Chairman of Section III, presented some ideas in an invited lecture on future needs in neutron dosimetry related to higher energies, higher intensities, pulsed beams and the Fusion Material Irradiation Facility (FMIF). He also noted problems with cross-section data.

5 DISCUSSION POINTS OF COMMON INTEREST

5.1 The CIPM MRA and matters of related interest

Prof. Wallard asked if more could be done to promote the CIPM MRA in the regulatory environment. Dr Allisy noted that, of the 11 000 'hits' on the website, only 3000 were from NMIs, the remainder possibly being made up largely of regulators and accreditors, although NMI customers were also known to use the site. A note on the new search engine could be usefully prepared for the regulatory environment. Prof. Moscati stated that, although attention should be paid to visibility, for example through the World Metrology Day, we should be cautious about getting involved in the work of regulatory bodies because of liability issues.

Dr Allisy noted the positive feedback expressed at the meeting of Section I that the CMCs in ionizing radiation were in very good order.

5.2 CCRI RMOWG

The question was raised whether the minutes of this WG meeting should be openly available; since the work of the RMOWG was already fully transparent to the NMIs and contained sensitive information on the status of laboratory Quality Systems, etc, it was agreed that it should remain a restricted document.

The issue of whether a confidence level of approximately 95 % should be stated, in relation to a coverage factor of $k = 2$, was referred to the RMOWG.

5.3 Other Working Groups

Dr Allisy noted that each Section meeting had reviewed its working groups and membership and that the outcomes would be reported to the CIPM.

5.4 *Metrologia* special issues

The *Metrologia* special issues had been discussed in each Section. Section I had confirmed the timetable and would launch a request for draft papers by the end of 2007. Section II was on track for publication around August 2007. Section III had agreed on topics and authors and had set a timetable. Dr Thomas suggested that the neutron special issue might turn out to be the most necessary of the three, since the information was not available elsewhere.

5.5 Future programme of the BIPM

Section I endorsed the BIPM programme and welcomed the move into new areas such as calorimetry, mammography and brachytherapy. In particular, Section I supported the proposal for an accelerator at the BIPM. Dr Allisy noted the lack of response to a call made in 2005 for secondments from the NMIs to the BIPM and suggested that perhaps a more detailed schedule could be prepared. Some recent interest had been shown by the ININ and the BEV. Prof. Wallard remarked that secondments had been successful in other areas, particularly in chemistry, and mentioned the 'top-up' allowance available to cover the added expense of living in Paris.

Dr Allisy discussed the CIPM proposal to make high-energy comparisons at an existing NMI facility and a recent request for a more formal response to this proposal. A meeting would be set up of representatives from interested NMIs to discuss the detailed logistics of such a comparison on an interim basis.

Dr Simpson noted that Section II was very happy with the current BIPM programme in activity, while Dr Thomas expressed the gratitude of Section III regarding the assistance given in the report of the neutron comparison at 24.5 keV.

5.6 Recommendations to the CGPM

While it was too late for any new Draft Resolutions to be put to the CGPM, the current agenda item was included to draw attention to the existing ones. Prof. Wallard noted the work being done with the World Customs Organization on Resolution 9 of the 2003 CGPM and reiterated the request that customs issues be brought to the attention of the BIPM.

5.7 Membership of Sections

Section membership had been adequately discussed at each of the Section meetings.

5.8 Future programme of the CCRI

Dr Allisy formally recorded the aim expressed at Section I to hold a brachytherapy workshop in association with the next Section I meeting, and the plan expressed at Section II to hold an uncertainty and key comparison workshop in 2008.

The resignation of Prof. Moscati in 2008 was discussed, particularly in relation to the likelihood of finding a replacement who could devote the time necessary to attend all three Section

meetings. The current practice of holding all three Section meetings around the same time was discussed. Dr Allisy highlighted the flexibility of the CCRI, pointing out that over the years many different *modus operandi* had been adopted, depending on the prevalent needs, and proposed that this historical information be pulled together for future discussion.

5.9 50th anniversary celebration of the CCRI in 2009

Dr Allisy noted that Prof. Moscati would be invited back in 2009 for this celebration, and that invitations would be sent out to previous BIPM staff members and to early members of the CCEMRI.

6 DATES OF NEXT CCRI AND SECTION MEETINGS

Appropriate dates around May 2009 would be proposed to the CGPM.

7 CONCLUDING REMARKS

Prof. Wallard expressed his formal thanks to the three Section Chairmen and to the BIPM staff, and his personal thanks to Prof. Moscati for his enormous effort and long-term commitment to the BIPM.

D.T. Burns, *rapporteur*

revised March 2009

RECOMMANDATIONS DU COMITÉ CONSULTATIF DES RAYONNEMENTS IONISANTS PRÉSENTÉES AU COMITÉ INTERNATIONAL DES POIDS ET MESURES

RECOMMANDATION R 1 (2007) :

Au sujet du changement de nom de la Section I du CCRI

Le Comité consultatif des rayonnements ionisants (CCRI),

considérant

- que les électrons ne sont pas les seules particules chargées qui intéressent la Section I du CCRI,
- que la Section I du CCRI doit donner son avis et des directives au sujet de la dosimétrie des faisceaux de protons,
- l'étendue des activités des laboratoires nationaux de métrologie dans le domaine de la dosimétrie des autres particules chargées,

recommande de changer le nom de la Section I du CCRI (rayons x et γ, électrons) en « rayons x et γ, particules chargées ».

RECOMMANDATION R 2 (2007) :

Sur l'extension de la validité de la comparaison clé CCRI(III)-K1 de mesures de débit de fluence de neutrons à 24,5 keV

Le Comité consultatif des rayonnements ionisants (CCRI),

considérant

- les recommandations de l'Organisation internationale de normalisation (ISO) à cette énergie,
- la nécessité que les résultats de cette comparaison publiés dans la base de données du BIPM sur les comparaisons clés (KCDB) étayent les aptitudes en matière de mesures et d'étalonnage (CMCs) des participants,
- les difficultés liées au transport des sources d'Am/Be vers les laboratoires nationaux de métrologie participants,
- que cette comparaison a duré trois ans,
- le travail à venir nécessaire à la Section III du CCRI afin de résoudre certaines questions relatives aux mesures,
- que cette comparaison a débuté avant la signature de l'Arrangement de reconnaissance mutuelle du CIPM (CIPM MRA),

recommande de reconnaître la validité de la comparaison clé CCRI(III)-K1 pour étayer les CMCs pendant une durée supérieure de cinq ans à la durée classique de dix ans, c'est-à-dire jusqu'en 2011, date à laquelle la comparaison, réalisée par tous les participants dans le laboratoire pilote, pourra être répétée dans le cadre de la série de mesures de fluence à différentes énergies de neutrons, à condition que la comparaison soit publiée avant la fin de 2007.

RECOMMENDATIONS OF THE CONSULTATIVE COMMITTEE FOR IONIZATION RADIATION SUBMITTED TO THE INTERNATIONAL COMMITTEE FOR WEIGHTS AND MEASURES

RECOMMENDATION R 1 (2007):

Change of name for the CCRI(I)

The Consultative Committee for Ionizing Radiation (CCRI),

considering

- that electrons are not the only charged particles of interest to the CCRI(I),
- the need for the CCRI(I) to provide advice and guidance on the dosimetry of proton beams,
- the scope of the work of the national metrology institutes in the dosimetry of other charged particles,

recommends that the name of Section I be changed from "x- and γ-rays, electrons" to "x- and γ-rays, charged particles".

RECOMMENDATION R 2 (2007):

Extension of validity of the CCRI(III)-K1 key comparison of neutron fluence rate measurements at 24.5 keV

The Consultative Committee for Ionizing Radiation (CCRI),

considering

- the recommendations of the International Organization for Standardization (ISO) for measurements at this energy,
- the need for this comparison as published in the BIPM Key Comparison Database (KCDB) to support the Calibration and Measurement Capabilities (CMCs) of the participants,
- the difficulties in transporting an Am/Be source to the national metrology institute participants,
- the three years that this comparison took to run,
- the further work that was required by the CCRI(III) of the participants to resolve some measurement issues,
- that this comparison was started before the CIPM MRA was signed,

recommends that on condition that this comparison is published before the end of 2007, the validity of the CCRI(III)-K1 comparison be accepted in support of CMCs for an extended period from the usual ten years for a further five years until 2011, when the comparison can be repeated as part of a series of fluence measurements at different neutron energies that will be carried out by all the participants at the pilot laboratory.

CONSULTATIVE COMMITTEE FOR IONIZING RADIATION

Section I: X- and γ-rays, electrons
Report of the 18th Meeting
(14-16 May 2007)

Abstract

The CCRI(I) meeting was preceded by a three-day Workshop on Air Kerma and Absorbed Dose Standards organized jointly by the LNE-LNHB and the BIPM. One of the outcomes of the workshop was a series of recommendations that were endorsed by the CCRI(I) and which identified outstanding issues that should be addressed by the NMIs or the BIPM. Dr Caporaso of the Lawrence Livermore National Laboratory gave an invited lecture describing recent work on developing a compact proton accelerator for radiation therapy. The meeting endorsed a plan by the BIPM to revise their standard for ^{60}Co air kerma and agreed that they should begin using their new ^{60}Co source for comparisons and as the basis of their calibration service. There were several reports on the development of standards and measurement techniques for low-energy x-ray beams produced by synchrotron facilities and there were indications that the relationship between air kerma and exposure may need to be revised for these low-energy beams. The expansion of high-energy x-ray and electron facilities at the NMIs was highlighted by the announcement of major new funding for the ARPANSA to acquire a clinical accelerator. The proposal to the CGPM for such a facility at the BIPM was endorsed. The CCRI(I) meeting in 2009 will be preceded by a one-day Workshop on Brachytherapy Standards.

1 OPENING OF THE MEETING; APPROVAL OF THE AGENDA; APPOINTMENT OF A RAPPORTEUR

Section I (x- and γ-rays, electrons*) of the Consultative Committee for Ionizing Radiation (CCRI) held its 18th meeting at the Pavillon de Breteuil (the BIPM headquarters), Sèvres, on 14, 15 and 16 May 2007.

The following Members and representatives were present: D. Butler (ARPANSA), I. Csete (MKEH), F. Delaunay (LNE-LNHB), S. Duane (NPL), S. Fedina (VNIIM), H.-M. Kramer (PTB), T. Kurosawa (NMIJ/AIST), F.J. Maringer (BEV), M. McEwen (NRC-INMS), G. Moscati (President of the CCRI), M. Pieksma (NMi VSL), M. Pimpinella (ENEA-INMRI), C. Ross (NRC-INMS), N. Saito (NMIJ/AIST), S.M. Seltzer (NIST and ICRU), P. Sharpe (NPL, Chairman of CCRI Section I), G. Stucki (METAS), M.P. Toni (ENEA-INMRI), E. van Dijk (NMi VSL), D. Webb (ARPANSA), Zhang Yanli (NIM).

Observers: J. Mostert (NMISA**), Z. Msimang (NMISA), J.G. Peixoto (LNMRI/IRD), K.R. Shortt (IAEA), V. Sochor (CMI), H. Svensson (IOMP).

Guests: G. Caporaso (LLNL), K.J. Chun (KRISS), 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, C. Kessler, C. Michotte, S. Picard, G. Ratel, C. Thomas (KCDB coordinator).

Apologies were received from J.-E. Grindborg (SSI).

The meeting was called to order at 10 am on 14 May 2007 by the Chairman, Dr Sharpe. Prof. Wallard, Director of the BIPM, welcomed the delegates to the BIPM and to the 18th meeting of the CCRI(I). He drew attention to the successful three-day Workshop that preceded the present meeting. This Workshop on Air Kerma and Absorbed Dose Standards was jointly organized by the BIPM and the LNE-LNHB and had been attended by many of those present for the CCRI(I) meeting.

Prof. Moscati, President of the CCRI, also extended a warm welcome to the delegates and welcomed new Members. He highlighted the importance of CCRI(I) support for the proposed BIPM accelerator facility. He announced that this would be his last meeting as President and noted the commitment of BIPM staff, especially Dr Allisy-Roberts, to organizing successful CCRI meetings.

Dr Sharpe proposed that delegates show their appreciation for the work of Prof. Moscati with a round of applause.

The delegates introduced themselves.

Dr Ross was appointed *rapporteur*.

---

* Change of name to be submitted to the CIPM.

** Formerly the CSIR-NML.

2 CHANGES OR ADDITIONS TO THE AGENDA

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

The agenda was adopted without change.

Dr Allisy-Roberts announced that the next CCRI meeting will mark its 50th anniversary.

3 REPORT OF THE CCRI, MAY 2005

The Chairman called attention to the reports of the 19th meeting of the CCRI and the 17th meeting of the CCRI(I) which are accessible through the web pages of the BIPM. It was noted that the 2005 meeting had been a great success, and one highlight was noted from each of the CCRI Section meetings. CCRI(I) had discussed and formulated an action plan for revising the BIPM ^{60}Co air kerma value. CCRI(II) had agreed on radionuclide groupings to reduce the number of laboratory comparisons, and CCRI(III) had undertaken a neutron fluence comparison in which the laboratories had taken their neutron standards to an NMI having a suitable accelerator.

Dr Sharpe noted that one of the issues raised at the 17th meeting concerned the definition of a suitable quantity for use with radiation beams when a factor is applied for the radiobiological effectiveness (RBE). Mr Seltzer had reported that the ICRU was discussing the issue and was likely to recommend a quantity RBE-weighted absorbed dose. Its SI unit would be the Gy (See also 13.2).

Dr Allisy-Roberts noted that security concerns continue to make it difficult to ship radioactive sources. She indicated that the IAEA had agreed to look at ways to help ease transport problems.

4 CURRENT ISSUES IN DOSIMETRY

4.1 Physical constants – *W/e* and stopping powers

Mr Seltzer reported that the ICRU has formed a report committee to prepare recommendations for key data used in radiation dosimetry. The committee held its first meeting in Barcelona in March 2007, and was being chaired by Dr J.M. Fernandez-Varea of the University of Barcelona. The tentative title for the report was “Key Data for Measurement Standards in the Dosimetry of Ionizing Radiation”. The committee might meet again in the winter and was interested in receiving any relevant data that could be supplied by the NMIs.

The Chairman thanked the ICRU for initiating this important effort.

4.2 The BIPM standards for air kerma

Dr Burns, referring to document CCRI/07-28 (access restricted), gave a detailed presentation on the status of the BIPM ^{60}Co air kerma standard. He noted that proposed changes to the BIPM standard, largely because of new evaluations of k_{wall} and k_{an}, had been presented to the last CCRI(I) meeting. A paper describing the Monte Carlo (MC) calculations underlying the changes was published in *Physics in Medicine and Biology*. Since then, more MC runs had been made to improve the statistics so that the proposed change is now about 0.08 % less than suggested in 2005.

Dr Burns went on to discuss a new and extensive set of measurements the BIPM has carried out using a variable volume ionization chamber. Additional details can be found in CCRI/07-27 (access restricted). The rationale for constructing a variable volume chamber was that it would permit a differential measurement of the charge per unit volume that would be insensitive to difficult or ill-defined volumes, such as those near the stem. The measurements showed that the charge per unit volume increased as the cavity size was increased. Possible reasons for the effect, which equates to a volume offset of less than 10 mm^3, have been explored but, to date, no satisfactory explanation has been found.

Delegates asked a number of questions regarding the results and it was clear that Dr Burns and his colleagues had carried out a very careful and detailed investigation of the behaviour of this new chamber. Dr Allisy-Roberts asked that the BIPM be permitted to continue its investigations of this anomaly before declaring a new air kerma standard. Dr Sharpe emphasized the importance of stability in the BIPM standards and that the number of changes be minimized. Delegates were sympathetic to the proposal that the anomaly associated with the new chamber be resolved before the BIPM standard was revised.

Dr Allisy-Roberts stated that the BIPM would like to switch to using their higher-intensity ^{60}Co source for air kerma and absorbed dose calibrations. Recent comparisons and calibrations have been made in both beams and show very good agreement when the beam radial non-uniformity is taken into account.

Dr Sharpe indicated that the consensus view of the delegates was that the BIPM should now use its higher-intensity source for comparisons and calibrations. A decision regarding a change to the BIPM standard was taken later in the meeting (see 5.2).

4.3 Feedback from the Primary Standards Workshop

Dr Sharpe stated that the LNE-LNHB/BIPM Workshop had been very successful and he formally thanked both organizations for their efforts in organizing the meeting.

A number of recommendations were put forward at the end of the workshop for consideration by the CCRI(I) and they are listed in CCRI(I)/07-53 (access restricted). Although non-binding, the intention of the recommendations is to provide guidance to the NMIs and the BIPM regarding the problems and issues that are most in need of investigation. The delegates discussed each recommendation and the following is the revised list that was accepted:

1. Noting that almost all absorbed dose standards are based on calorimetry, the CCRI(I) encourages the NMIs and the BIPM to continue to develop different methods of measuring absorbed dose for robust determinations.

2. Recognizing the innovative approach of the NIST to use ultrasound to measure temperatures in their sealed water phantom operating at room temperature, the CCRI(I) encourages all NMIs and the BIPM to investigate alternative temperature measurement techniques to lower the dose-rate threshold for absorbed dose measurements.
3. In view of the likely future expansion of proton and carbon-ion therapy systems, and the need for accurate and traceable dosimetry, the CCRI(I) encourages the NMIs and the BIPM to pursue the goal of developing portable, charged particle dosimetry standards to meet these future needs.
4. In view of some unexpected results obtained at low air density, which might occur at high altitudes, and particularly for cavity chambers measuring low-energy x-rays, the CCRI(I) asks the NMIs to indicate what advice they give to their customers regarding the interpretation of ionization chamber responses under these conditions, with a view to providing some recommended guidance. In support of this, the NMIs and the CCRI(I) are invited to make any long-standing documents and reports that are particularly relevant to pressure effects available on the internet. Mr Seltzer suggested that this might be a suitable problem for the SIM to investigate because it has standards laboratories at widely different altitudes.
5. The CCRI(I) encourages the Brachytherapy Standards Working Group (BSWG) to pursue their planned comparisons and requests that they consider the future development of direct absorbed dose standards for brachytherapy source comparisons. In addition, as well-type chambers are often used as transfer standards for low-energy brachytherapy sources, the BSWG(I) is requested to look into the effects of low air density on well-chamber responses (see 4 above).
6. In view of the differences in response of some passive dosimeters, particularly for low energy brachytherapy sources for which there can be up to 10 % difference between dose-rate constants measured by different techniques, the CCRI(I) encourages the NMIs to provide data to the BSWG(I) on the low energy responses of the various passive dosimetry systems.
7. It was reported that in free-air chambers operating in low-energy x-ray beams, the charge of secondary and Auger electrons, and that of the corresponding positive ion, is measured, but that this might not be consistent with the value used for W. Dr Saito presented a slide at the CCRI(I) indicating the problem related to W/e for low-energy x-ray beams. There was agreement that this is an important issue that needs additional investigation. Consequently, the CCRI(I) encourages the NMIs and the BIPM to investigate this effect which might be as high as 1 % at 3 keV and 0.4 % at 10 keV, to publish their findings and to consider the need for corrections.
8. In view of the large number of bilateral comparisons initiated in the EURAMET (the former EUROMET) to ensure traceability, the CCRI(I) supports a BIPM comparison of primary standards at mammography energies, which would be an important adjunct to the CCRI(I) comparisons at low energies.
9. The CCRI(I) discussed the possible causes of discrepancies in k_{wall} correction factors calculated by MC methods. In view of the measurement evidence leading to the conclusion that the calculated wall effect for cavity standards might be in error by up to 5 %, which would be significant for standards that require large corrections, the CCRI(I) encourages the NMIs to submit experimental evidence for analysis by the Key Comparisons Working Group (KCWG(I)).

10. The CCRI(I) encourages the BIPM co-author to discuss with the PTB a possible misinterpretation of the recommendation in the IAEA TRS 398 regarding ion recombination corrections for therapy secondary standards.
11. The CCRI(I) encourages the PTB and NIST representatives on the ISO drafting committee for beta dosimetry to consider a possible 2 % discrepancy between calculated values and measured values of beta absorbed dose.
12. While all NMIs use standard reference conditions to realize their primary standards, radiotherapy is becoming increasingly complex with modulated fields that are not easily reproducible in a standards laboratory, and consequently, the CCRI(I) invites the NMIs to investigate the dissemination of their primary standards to realistic radiotherapy fields.
13. In view of the comparison of ionometric and calorimetric determinations of absorbed dose to water made at the PTB, the CCRI(I) encourages the NMIs and the BIPM to produce more experimental evidence and transparent MC calculated evidence regarding stopping power ratios for cavity standards as input data to the ICRU Report Committee on physical constants for dosimetry.
14. In view of the reduced uncertainty achieved when ionization chambers are calibrated directly in electron and other charged particle beams, the CCRI(I) encourages the NMIs to undertake both MC calculations and measurements to identify appropriate perturbation corrections for the different types of ionization chambers used as dosimetry secondary standards and to report these to the next CCRI(I).
15. Bearing in mind the recommendations in TRS 398 for direct calibrations in high-energy x-ray beams and the significant chamber-to-chamber variations observed in measured k_Q factors, the CCRI(I) supports the direct comparison of primary standards used for high energies.
16. In order to identify and evaluate possible discrepancies when calibrating chambers for high-energy dosimetry, the CCRI(I) encourages the NMIs to contribute their data to a CCRI(I) publication so that the variations within and between chamber types are readily available.
17. On the assumption that a one-day topic-specific workshop, possibly on brachytherapy standards, will probably be held in 2009 in conjunction with the next CCRI(I) meeting, the CCRI(I) will liaise with the IAEA over the date of their planned Dosimetry Conference, and will invite all NMIs to respond to a questionnaire on the scope and location of a future broad-based dosimetry workshop or conference to be held in 2011 as a sequel to the successful joint LNE-LNHB/BIPM Workshop held in Paris in May 2007.

5 COMPARISONS OF DOSIMETRY STANDARDS (X- AND γ-RAYS)

5.1 BIPM and CCRI key comparisons

Referring to CCRI(I)/07-30, Dr Allisy-Roberts presented an overview of the dosimetry comparisons and calibrations conducted at the BIPM since the 2005 CCRI(I) meeting. She reminded delegates that laboratories must participate in a comparison every ten years if they wish to maintain their listing in the KCDB. A five-year extension beyond the ten-year limit is possible as long as the appropriate comparison has been scheduled.

Dr Allisy-Roberts reported that a ^{192}Ir brachytherapy source dosimetry comparison that was planned for 2006 (CCRI(I)/07-31, access restricted) had not actually taken place because of lack of personnel, although the transfer instrument had been purchased. The second brachytherapy comparison of 125I seeds is also to be coordinated by the BIPM who would purchase and characterize 50 seeds that would then be sent in groups of five to each of the participating laboratories. Although funds are available to purchase the seeds, the BIPM did not have personnel to commit to the project so no progress had been made. She called on the NMIs to propose staff secondments to the BIPM to help organize these comparisons.

With regard to high-dose comparisons, the last comparison was carried out in 1998 and the results were published in 2006. Mr Seltzer indicated that the NIST would like to propose a new comparison (CCRI(I)/07-45, access restricted), which would also be used to help resolve a possible dose-rate dependence in the response of alanine dosimeters. The Chairman asked for an indication of how many laboratories would be interested in participating with the NIST and at least six responded positively: the BEV, ENEA-INMRI, LNMRI, NIM, NPL, PTB, and possibly the ARPANSA, LNE-LNHB and the NMIJ. Dr Allisy-Roberts indicated that the BIPM would be prepared to lead the comparison and the intention would be to have it completed before the next CCRI(I) meeting. The BIPM, NIST and the NPL would draft the protocol.

5.2 Appendix B (CIPM MRA) comparison reports

Dr Allisy-Roberts presented the Draft B report for comparison BIPM.RI(I)-K1, air kerma in ^{60}Co radiation (see CCRI(I)/07-46, access restricted). This report summarizes the results of comparisons between the BIPM and sixteen NMIs. As the BIPM has not yet revised its ^{60}Co air kerma standard, Dr Allisy-Roberts proposed to publish only the tables showing the degrees of equivalence (D_{ij}) between the NMIs and not report results with respect to the KCRV.

Dr Ross indicated that an additional delay in revising the BIPM air kerma standard would create a problem for the SIM comparison reports which are now in the Draft B stage, because the results have been reported in terms of the revised air kerma standards of the NRC, the NIST and the BIPM. Mr Seltzer pointed out that the SIM secondary laboratories, which are all traceable to the BIPM, would appear discrepant with respect to other NMIs if the BIPM value were not adjusted. Dr Kramer stated that readers of the report will know there is a problem if only the D_{ij} values are reported for BIPM.RI(I)-K1.

Mr Seltzer pointed out that other NMIs carried out MC calculations of k_{wall} and k_{an} and adjusted their standards accordingly. He proposed that the BIPM should revise their standard based on their published values for k_{wall} and k_{an}.

In view of the opinion of the delegates, Dr Allisy-Roberts proposed that Dr Burns will submit for publication the present best estimate of the change in the BIPM ^{60}Co air kerma standard. The new value for the BIPM air kerma standard will be implemented once published. The NMIs that have BIPM calibrations will be given at least one month's notice of this. Although an earlier proposal was to await further investigation (see 4.2), delegates expressed their satisfaction with this new proposed course of action. Dr Burns agreed to present the data underlying the proposed change as well as the associated uncertainties on the Wednesday morning of the meeting and the way forward would then be decided. This presentation is included here for completeness.

Referring to the supplementary document CCRI(I)/07-54 (access restricted), Dr Burns described the factors that will influence the change in the BIPM ^{60}Co standard for air kerma. This will take

into account results obtained with the new variable volume chamber as well as improved MC calculations of the correction factors k_{wall} and k_{an}. The overall change will lead to higher values of the air kerma by a factor of 1.0054. The standard uncertainty in the air kerma as established with the present standard is 0.17 % while the uncertainty of the revised standard will be 0.15 %.

After some discussion of technical issues regarding the measurements and calculations, the delegates endorsed the BIPM proposal to revise their ^{60}Co standard for air kerma by a factor of 1.0054. This would enable the BIPM.RI(I)-K1 results to be re-evaluated and published. It was pointed out that this change will not affect the KCRV, which is always unity. The change would also enable the various RMO air-kerma comparisons to have their links established to the BIPM ongoing comparison.

The proposed change will be submitted for publication and once in print a notice will be sent to all NMIs announcing the change.

5.3 Regional key and supplementary comparisons

This agenda item was postponed until Tuesday morning so that Dr Shortt could be present for the discussion of the SIM Draft B reports.

Dr Burns gave an overview on calculating degrees of equivalence and corresponding uncertainties in regional dosimetry comparisons (CCRI(I)/07-04) explaining that this was not a prescription, but might be helpful guidance. To illustrate the key ideas, he considered a single laboratory in the comparison that was linked to the KCRV, but the paper shows how this result can be generalized.

In response to a question from Dr Ross regarding the equation used for incorporating the effects of correlations, Dr Allisy-Roberts indicated that the BIPM is developing a more formal approach for handling correlations with the help of Dr C. Sutton (MSL, New Zealand).

Dr Kurosawa described a proposal (CCRI(I)/07-02, access restricted)) for a low-energy x-ray comparison between the NMIJ/AIST (Japan) and the INER (Chinese Taipei). The NMIJ/AIST will act as the pilot laboratory and the free-air chamber of the INER will be transported to Japan. Dr Webb suggested that additional laboratories may wish to be added to the comparison.

Dr Ross summarized the Draft B reports arising from SIM comparisons SIM.RI(I)-K1 and SIM.RI(I)-K4. The comparisons were carried out during 2000 to 2002, but since then the air kerma standards of the NRC and the NIST have been revised. As a change was also proposed for the BIPM standard, the air kerma report was prepared based on the revised standards. This would need to be readjusted depending on the final figure for the BIPM standard.

Dr Allisy-Roberts asked why the uncertainties on the degrees of equivalence between the secondary laboratories were so large, given that they were all traceable (either directly or through the IAEA) to the BIPM air kerma standard. Dr Ross pointed out that some of the laboratories report uncertainties on the calibration coefficients of their secondary standards that are much larger than would be expected given the uncertainty quoted by the BIPM. There was considerable discussion among the delegates regarding the question of uncertainties, and Dr Allisy-Roberts wondered if some of the laboratories had reported $k = 2$ uncertainties rather than standard uncertainties.

Dr Sharpe pointed out that the air kerma report would need to wait for the formal announcement of the change in the BIPM air kerma standard. The reports will need to be referred to the KCWG(I).

Dr Chun reported on the APMP.RI(I)-K1 ^{60}Co air kerma comparison that is being led by the KRISS and involves ten NMIs (CCRI(I)/07-48, access restricted)). Difficulties with getting the necessary customs clearances have led to some delays in completing the comparison. Dr Chun also proposed a ^{137}Cs air kerma comparison (APMP.RI(I)-K5). Dr Sharpe pointed out that this comparison has not yet been approved, pending some issues that must be resolved. It would be submitted to the APMP Conference in October 2007.

A ^{90}Sr check source had been used for the APMP.RI(I)-K1 comparison and Dr Allisy-Roberts asked if this was an acceptable technique for checking chamber stability. Dr Csete suggested it was an unnecessary complication and Dr Kramer pointed out that the standard P, T correction might not work for these check sources, given the information that was presented at the Workshop.

5.4 Calibration of transfer standards

An earlier report (CCRI(I)/03-54, access restricted) summarized measured values of the ratio of $N_{D,w}$ to N_K for ^{60}Co γ-rays as obtained by several standards laboratories. The intention had been to publish these data in the open literature, but no progress has been made on producing the paper. As many standards have changed since the data were collected, considerable effort is required to update the results. Dr Duane, who has the data set up to 2003, volunteered to ask the laboratories to update their earlier data as well as to provide more recent results.

Guest Seminar - a novel concept for a compact proton accelerator

After the session on Monday, Dr Caporaso of the Lawrence Livermore National Laboratory (United States of America) gave a presentation on a novel concept for a compact proton accelerator. The abstract of his talk is available as CCRI(I)/07-01. The accelerator relies on the development of high-performance insulators and is predicted to be able to achieve an acceleration gradient of 100 MeV/m. As the accelerator has a small size, no magnets will be required to transport the beam to the treatment room. Dr Caporaso's group has formed a collaborative agreement with a commercial company who plan to incorporate the accelerator into a machine similar in design to their present 6 MV tomotherapy x-ray machine.

6 CURRENT AND FUTURE PROGRAMME AT THE BIPM

Dr Allisy-Roberts gave an overview of the BIPM activities for the past two years and presented a series of topics that the BIPM will be engaged in over the coming years. She referred delegates to the BIPM annual report for 2005/06 that is available on the BIPM website. Document CCRI(I)/07-47 (access restricted) gives the work programme for ionizing radiation that will be submitted to the CGPM in November 2007.

She noted that new environmental regulations in 2005 had classified the BIPM as a "nuclear installation" and required that they put in place additional security measures for their ^{60}Co sources as well as assess the risk posed by the SIR sources. The external consultant's report concluded that the accidental release of all the SIR sources would pose no significant risk to the public or the environment. The regulations had changed again in November 2006 and the BIPM was no longer classified in this way.

It was noted that new half-life values for ^{60}Co and ^{137}Cs have been published (*BIPM Monographie 5*, vol. 3) and those measured at the BIPM agreed with these new values within the standard uncertainties.

There had been a successful external audit in 2006 of the Quality System underpinning the ionizing radiation calibration services.

In addressing the proposal to establish a clinical accelerator facility at the BIPM, she summarized feedback from the directors of some of the NMIs. It was felt that a machine with a beam quality approaching 25 MV was necessary, even though this would increase the shielding requirements due to neutron production. It was also suggested that options for external funding should be pursued but, so far, these efforts have not met with success. The intention of the CIPM is to ask the CGPM for support in principle at the meeting in November 2007, but it is not likely that the facility would be funded until the 2013-2016 programme.

Dr Sharpe expressed his thanks to Dr Allisy-Roberts and her staff for their efforts in support of ionizing radiation standards and dosimetry.

Ms Kessler reported on work at the BIPM to establish a new standard and comparison facility for mammography (CCRI(I)/07-08, access restricted). A new x-ray tube with a molybdenum anode is being installed and a new free-air chamber designed for low-energy x-rays has been built. The correction factors for the new chamber are being calculated using the PENELOPE MC code. An initial comparison between the new free-air chamber and the existing one shows satisfactory agreement.

Dr Picard discussed work at the BIPM to develop a graphite calorimeter as a standard for absorbed dose to water (CCRI(I)/07-03, access restricted). She described why the BIPM had opted for graphite, rather than water calorimetry. An important part of the project is the measurement of the specific heat capacity of graphite and she discussed the technique that had been developed and the results obtained. Key elements of the calorimeter are under construction.

Dr Burns described new MC calculations that have been carried out for the present BIPM absorbed dose to water standard (CCRI(I)/07-28, access restricted). The present values for the various correction factors were obtained using analytical and semi-empirical techniques and the MC calculations predict the largest changes will be for $\beta_{w,c}$ and k_{cav}. Initial results suggest an increase in the value of D_w of about 0.4 %, but no changes to the standard are proposed at this time.

7 DEVELOPMENT OF NATIONAL STANDARDS FOR PHOTON DOSIMETRY

7.1 Air kerma

Mr Seltzer reported that the NIST is building a new free-air chamber to replace the Wyckoff-Attix free-air chamber that has been in service for almost 50 years. The NIST has participated in EUROMET 545, a comparison of narrow-beam x-ray qualities for tube potentials from 30 kV to 300 kV. With respect to ^{60}Co air kerma (CCRI(I)/07-12), Mr Seltzer reported that there had been no changes to the standard since the last CCRI meeting. Transfer chambers have been used to disseminate the standard to secondary laboratories throughout the United States of America. Differences between the transfer chambers and secondary standards maintained by the laboratories were less than 0.2 %.

Dr Kramer reported on documents CCRI(I)/07-21 and CCRI(I)/07-22. He highlighted four points:

- the establishment of new mammography x-ray qualities at the PTB;
- the measurement of low-energy mass energy absorption coefficients using synchrotron radiation;
- the observation of discrepancies between air kerma values measured with a free-air chamber and a cavity chamber; and
- the establishment of a free-air chamber for tube potentials up to 450 kV.

Referring to CCRI(I)/07-29, Dr Toni discussed recent work on air kerma standards at ENEA. They operate two free-air chambers, one based on the Attix design for high energies and one based on a parallel-plate design for low energies. They have used their low-energy free-air chamber to characterize the synchrotron x-ray beam (8 keV to 35 keV) used for mammography at ELETTRA. The PENELOPE MC code was used to calculate the necessary corrections. Using a vacuum chamber, they were able to measure the air mass attenuation coefficient in the energy range from 8 keV to 30 keV. Differences between measured and tabulated values were from 0 to 3 %.

7.2 Absorbed dose to water

Mr Seltzer reported on work at the NIST on analysis in the frequency domain of calorimetry runs (CCRI(I)/07-14). They have also been testing a new sensor based on ultrasound that is capable of showing the onset of convection. In response to a question from Dr McEwen, Mr Seltzer stated that approximately half their calorimetry work has been done using ^{60}Co γ-rays and half using MV x-rays.

Dr Kramer described the present status of the new PTB electron accelerator facility (CCRI(I)/07-23). The two clinical machines will be operational in late 2007 while the research machine will be commissioned in early 2008. The new facility will be named after Dr Glocker, a pioneer in the use of high-energy x-rays for radiation therapy. A key comparison for ^{60}Co absorbed dose to water between the PTB and the BIPM has been completed and the results published. Preliminary absorbed dose measurements using a water calorimeter in a low-energy x-ray beam and with a ^{192}Ir source are quite encouraging.

Dr Pimpinella described the ENEA absorbed-dose-to-water standard, which is based on a graphite calorimeter and transfer ionization chambers (CCRI(I)/07-29). Recent improvements include the use of MC calculations to obtain k_{gap} and $\Psi_{w,c}$. The overall uncertainty on the absorbed dose to water in a ^{60}Co beam is 0.36 %.

Dr Maringer described the BEV standard for absorbed dose to water (CCRI(I)/07-40). The intention is to upgrade their graphite calorimeter and extend its range of operation to include clinical accelerator beams. The calorimeter and ionization chamber measurements will be carried out at clinical accelerators in Vienna outside normal clinical hours and their plan is to have a working primary standard within two years.

Dr McEwen reviewed the NRC accelerator facility and its water calorimeter (CCRI(I)/07-18). The calorimeter has been used to establish a calibration service for high-energy x-ray beams. The standard uncertainty on the calibration coefficient for a well-behaved ionization chamber is 0.35 %.

Dr Webb reported on successful efforts at the ARPANSA to repair their graphite calorimeter and to compare it with a graphite calorimeter on loan from the IAEA (CCRI(I)/07-06). The difference between the two calorimeters of 0.2 % is not considered to be statistically significant. Dr Webb was pleased to announce to the meeting that the ARPANSA has been awarded funding to upgrade its ionizing radiation standards capabilities, including the purchase of a clinical linear accelerator to replace their existing facility. They are planning to purchase an accelerator equipped with a multi-leaf collimator.

Dr Webb's announcement led to some discussion of the work that can be done with a clinical machine, and Dr Shortt pointed out that the IAEA, the Institute of Physics and Engineering in Medicine (IPEM) and the American Association of Physicists in Medicine (AAPM) are working together to produce a protocol for small-field dosimetry. Mr Seltzer and Dr McEwen summarized the AAPM activities in this area and it seems that the AAPM might need to produce a separate document for United States of America clinics. Thus although this will be a coordinated parallel activity, a subset of the IAEA Code of Practice may result. Dr Csete stated that EURAMET has a research proposal for 3D dosimetry for ^{60}Co and MV x-ray beams.

Dr Kurosawa reviewed both air kerma and absorbed dose activities at the NMIJ/AIST (CCRI(I)/07-20). They have carried out extensive studies of the effect of scattered radiation in kV x-ray beams on the response of their free-air chamber and transfer chambers. Using a shadow technique whereby the primary beam is blocked, they showed that the effect of scatter is larger for standard cavity ionization chambers than it is for a free-air chamber. They have also used MC techniques to study the effect of aperture scattering on the response of a free-air chamber. The entrance angle of the aperture has a significant effect on the scatter contribution. With regard to absorbed dose, they have begun a programme to develop a standard based on graphite calorimetry.

7.3 Brachytherapy dosimetry

Mr Seltzer reported that the NIST calibration activity for brachytherapy seeds has been steady at about 100 seeds per year (CCRI(I)/07-16). Manufacturers are required to send seeds periodically to the NIST and in turn the NIST sends calibrated seeds to the Accredited Dosimetry Calibration Laboratories (ADCLs). The ADCLs use these reference seeds to establish secondary standards that can be used to calibrate clinical chambers. In response to a question from Dr McEwen, it

was pointed out that the NIST standard chamber (the WAFAC) is operated at only two different chamber volumes, while the PTB chamber (the GROVEX) is a true extrapolation chamber.

Dr Kramer highlighted three developments at the PTB related to brachytherapy and low-energy x-ray sources (CCRI(I)/07-23).

- The new PTB standard for low-energy brachytherapy seeds, the GROVEX chamber, is now in operation. This is a true extrapolation chamber with guard bars to define the electric field lines.
- A graphite extrapolation chamber is being used to establish the absorbed dose to water for x-rays below 50 keV.
- A multi-electrode extrapolation chamber (MEK) has been developed as a standard for $^{90}Sr/^{90}Y$ sources. A scientific investigation has been carried out with the NIST to develop the values for the correction factors.

Dr Csete summarized a EURAMET proposal to establish brachytherapy standards based on absorbed dose to water (CCRI(I)/07-37) at a depth of 1 cm. The dose to water would be established at the centre of a water phantom using water or graphite calorimetry, or possibly some other technique. The new standard would be used to calibrate well chambers. Measurements and MC calculations would be used to establish the 3D dose distribution.

Dr van Dijk reported that the NMi is studying ways to establish an absorbed dose standard for low-energy brachytherapy sources (CCRI(I)/07-26) using a cylindrical ionization chamber with ^{125}I seeds placed in the centre.

Dr Delaunay reported that the LNHB is building a toroidal ionization chamber that will be used as a standard for low-energy brachytherapy sources (CCRI(I)/07-25).

Dr Duane reported that the NPL has built a graphite calorimeter that will be used as a standard for high-dose rate brachytherapy seeds (CCRI(I)/07-33). The calorimeter will operate in constant temperature mode.

Dr Allisy-Roberts proposed that the next CCRI(I) meeting in 2009 be preceded by a one-day workshop on brachytherapy standards and comparisons. This proposal was endorsed by the CCRI(I).

7.4 Radiation processing

Dr Zhang reported on dosimetry for radiation processing in China. Further details can be found in document CCRI(I)/07-43, and he pointed out that there is a large number of radiation processing facilities in China that need to be calibrated annually. Primary dosimetry is based on the Fricke dosimeter, although dichromate solution and alanine pellets are used as transfer standards. Alanine dosimeters are distributed as part of a quality assurance programme, and facilities are typically found to be within 5 % of the expected value. The NIM participated in the high-dose comparison in 1998 and would like to take part in the next CCRI(I) high-dose comparison.

Referring to document CCRI(I)/07-15, Mr Seltzer pointed out that the NIST and the NPL participate in an annual high-dose comparison and that this comparison is now part of the NIST Quality System. There is a historic difference between the NPL and the NIST of 1.2 % to 1.9 %. The NIST is moving ahead with an internet-based alanine calibration service, although the accuracy (4 % to 5 %) will be poorer than with the mail-out service.

In reference to page 14 of the NIST programme (CCRI(I)/07-17), Dr McEwen discussed collaborative work between the NPL and the Risø National Laboratory at the Technical University of Denmark on developing a standard for low-energy electron beam dosimetry. The standard is based on a simple graphite calorimeter that can be used to calibrate more conventional dosimeters. Some members referred to this as the "Lego calorimeter" because it is built on a base constructed of Lego pieces.

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

Dr Kramer described work at the PTB to develop an electrical substitution radiometer that can be used for x-ray energies from 1 keV up to 60 keV. The device is described in detail in CCRI(I)/07-24 (access restricted), and uses an absorber with a gold base and a copper shell. The intention is to use it for accurate measurements of mass energy absorption coefficients in the energy range up to 60 keV.

Referring to CCRI(I)/07-20, Dr Saito described the performance of a cryogenic substitution radiometer for the energy range from 0.1 keV to 4 keV. The device can be used to measure either photon intensity or beam power. It has been used to calibrate photodiodes and measure W. A comparison with the PTB is in progress.

8 DEVELOPMENT OF NATIONAL STANDARDS FOR CHARGED PARTICLE DOSIMETRY

8.1 Electron/beta dosimetry

Referring to CCRI(I)/07-29, Dr Pimpinella described the ferrous sulphate dosimetry programme at the ENEA. Due to its dose rate independence, the ferrous sulphate dosimeter is a good choice for applications that use a high dose per pulse, such as inter-operative radiation therapy. About 1 cm^3 of dosimeter solution is flame-sealed in glass ampoules. Dosimeters are calibrated using ^{60}Co and MC calculations are used to account for the non water-equivalence of the dosimeter. The correction is small for high-energy electron beams ($R_{50} > 2.4$ g/cm^2) but is as large as 2.8 % for low energy beams.

She also reviewed work at the ENEA on the effect of ion recombination on ionization chamber response when the dose per pulse is very high, up to 120 mGy. In this case, the effect of free electrons must be carefully considered.

Dr Duane discussed the p_{wall} correction as used for the NPL electron beam calibration service. The UK Code of Practice for electron dosimetry assumed that p_{wall} is unity but recent work by several groups gives values that depend on beam quality and differ significantly from unity. Additional details can be found in CCRI(I)/07-33.

Referring to document CCRI(I)/07-13, Mr Seltzer summarized recent β-ray comparisons. The NIST participated in a EURAMET comparison of β-ray dosimetry for radiation protection and is involved in bilateral comparisons with the NMi and the PTB. He also pointed out that the NIST is working on using 3D gel dosimetry to measure β-ray dose distributions. In response to a

question from Dr Kramer, he stated that the gel readout is based on a commercially available optical tomography system.

Referring to Section 5 of CCRI(I)/07-20, Dr Saito reviewed recent work at the NMIJ on β-ray standards. They have participated in the recent EURAMET comparison and plan a comparison with the KRISS in 2007.

Dr Sochor (CMI) stated that they are also exploring gel dosimetry but their results are still preliminary.

The Chairman suggested that gel dosimetry be a specific topic for the next CCRI(I) meeting.

Dr McEwen, referring to document CCRI(I)/07-18, discussed recent work at the NRC on electron calorimetry. Several chambers have been calibrated at electron energies from 12 MeV to 22 MeV and preliminary results indicate differences with the calibration coefficients that are obtained from protocols.

It was noted that water calorimetry in electron beams is developing rapidly with several NMIs starting work in this field.

Dr Stucki expressed an interest in comparing electron beam dosimetry between the NRC and the METAS in one year's time. Dr Sharpe pointed out that an NPL-METAS comparison is already planned so it might be broadened to include the NRC as a EURAMET comparison.

8.2 Protons

Referring to document CCRI(I)/07-33, Section 6.3, Dr Duane discussed recent work at the NPL on proton dosimetry. A new graphite calorimeter for proton dosimetry is in the design phase. As part of a collaborative arrangement with the Clatterbridge Centre for Oncology (United Kingdom), various problems related to proton dosimetry are under investigation. This includes studies of ion recombination in proton beams and the calculation of ionization chamber perturbation factors. He confirmed that his calorimeter could also be used in ^{12}C ion beams, although some questions would need to be resolved.

With reference to document CCRI(I)/07-10, Dr Stucki described a project involving METAS and the proton therapy facility at the Paul Scherrer Institute (Switzerland). Initial investigations have shown that a water calorimeter similar to the METAS high-energy x-ray calorimeter can be used in a scanned 200 MeV proton beam.

8.3 Other charged particles

Dr Kramer reported that initial measurements using water calorimetry by the PTB at the Gesellschaft für Schwerionenforschung mbH (GSI) carbon ion facility in Darmstadt are quite promising. He referred to Dr Krauss' presentation at the LNE-LNHB/BIPM Workshop. He also raised the question of accounting for the RBE for these beams in the future (see also 13.2).

8.4 Proposal to modify the name of CCRI Section I

At the CCRI meeting of 2005, Dr Sharpe had proposed changing the name of Section I from "x- and γ-rays, electrons" to "x- and γ-rays, charged particles". Delegates felt this was an appropriate

change that reflected the increased importance of proton therapy. A formal recommendation was approved by the CCRI (Recommendation R 1 (2007)).

9 FUTURE TRENDS IN DOSIMETRY: ROADMAPS

Dr Kramer discussed plans for dosimetry within the European Union under the new EURAMET programme. Three roadmaps have been established for ionizing radiation research:

1. Metrology for New Radiodiagnostic and Radiation Therapy Modalities;
2. New Physical Concepts and Metrology for Quantifying Radiation Interaction with Matter;
3. Metrology for Novel Radiation Sources.

Dr Csete pointed out that, to date, no money has been assigned for work on these new programmes.

Dr McEwen indicated that these were ambitious new programmes that were anticipating significant new resources into the future, but it was important to obtain a commitment to obtain an accelerator for the BIPM. Views were expressed that the BIPM should not be left without the facilities to participate, and it was thought that the BIPM might use the EURAMET roadmaps as further independent evidence to strengthen its case to obtain a clinical accelerator.

10 OTHER REPORTS FROM MEMBER LABORATORIES

Dr Kramer summarized work reported in CCRI(I)/07-21 on nano-dosimetry. Track structure simulations have been able to show that measurements of ionization cluster size distributions using low-pressure gas can be applied to cluster size distributions in liquid water. It may be that the cluster size distribution can lead to a new definition of radiation quality that better expresses the relative biological effectiveness.

He then turned to document CCRI(I)/07-22 and described efforts to modify the existing PTB standard for $H^*(10)$. By adding a shell of Makralon (polycarbonate) to the existing spherical chamber, they were able to produce a device with an energy response that is flat to within 10 % from 12 keV to ^{60}Co γ-rays.

The Chairman then advanced around the table asking each laboratory if they had any additional information they would like to convey to the meeting.

Dr Maringer (BEV) suggested that a working group on accelerator-based standards and measurement techniques should be formed. Dr Sharpe asked that further discussions of this matter be postponed until working groups were discussed (see section 15).

Dr Zhang indicated that the NIM is updating its graphite calorimeter and exploring the possibility of developing a water calorimeter.

Dr Webb (ARPANSA) summarized their success in repairing their graphite calorimeter and comparing it with the IAEA calorimeter. He also reminded the delegates that the ARPANSA has just been awarded significant new funding to upgrade its facilities, including the purchase of a clinical accelerator.

Mr Seltzer (NIST) informed the delegates that Dr Hubbell had passed away recently. Dr Hubbell was a NIST scientist who was recognized around the world for his work on photon interaction data. On behalf of delegates, Dr Sharpe expressed his condolences to Mr Seltzer and the NIST staff.

Dr Duane (NPL) reported that they would be installing a clinical accelerator in a newly constructed building in the near future.

Dr Saito (NMIJ/AIST) pointed out that they were installing an x-ray tube with a Mo target so as to be able to provide calibrations for mammography. They also have established a spectrometer that allows them to measure low-energy x-ray spectra. Additional details are available in document CCRI(I)/07-20.

Dr McEwen (NRC) summarized work reported in document CCRI(I)/07-18 on measurements and calculations to determine the effective point of measurement of an ionization chamber in high-energy x-ray beams. MC calculations are able to predict the position of the point of measurement and experimental results for a wide range of chambers are in excellent agreement with the calculations.

Referring to document CCRI(I)/07-25, Dr Delaunay (LNHB) pointed out that they have developed a new set of cavity chambers as the basis of their ^{60}Co air kerma standard. They have also done some work to compare dose distributions predicted by treatment planning systems with measured dose distributions.

Dr Csete (MKEH) stated that they might have to relocate their laboratory.

Mrs Fedina (VNIIM) pointed out that they have upgraded their medium energy x-ray facilities and obtained new correction factors for their free-air chambers, which would change their degrees of equivalence. There are also plans to upgrade their low-energy x-ray capabilities. New graphite cavity chambers for ^{60}Co air kerma have been obtained and correction factors calculated using MC techniques. The VNIIM is participating in various comparisons including a EURAMET ^{60}Co air kerma comparison and a EURAMET comparison for absorbed dose to tissue from β-rays. Additional details are available in document CCRI(I)/07-35.

Dr van Dijk (NMi), referring to document CCRI(I)/07-26, pointed out that the NMi has recently moved to new laboratory space in Delft. They have used a water calorimeter to measure k_Q factors for a range of ionization chambers and these factors will be used in a new dosimetry protocol. They have had considerable success in using water calorimetry to measure D_w in medium-energy x-ray beams. A new activity to study ways of verifying three-dimensional (3D) dose distributions predicted by treatment planning systems has been started.

Referring to CCRI(I)/07-09, Dr Sochor (CMI) described their role in calibrating instruments and type-testing. At the present time they have no primary standards but are developing a graphite cavity chamber for ^{60}Co air kerma. They are also developing an extrapolation chamber that can be used to measure the absorbed dose from ophthalmic applicators.

Dr Mostert (NMISA) explained that they act as a secondary laboratory and have no primary standards. They are interested in developing standards for diagnostic radiology and have

established a technical cooperation project with the IAEA. He pointed out that they are now part of a new institute, the NMISA (see CCRI(I)/07-52) as the CSIR-NML ceased to exist on 30 April 2007.

Dr Peixoto reported that the LNMRI has acquired a new 160 kV x-ray tube. They are improving their network for the dissemination of standards for diagnostic radiology. He apologized for not having submitted a paper to the meeting and indicated that this would be done for the next CCRI(I) meeting.

Dr Los Arcos (CIEMAT) was pleased to have been invited as a Guest and reported that they are extending their x-ray capability to include mammography. They plan to compare their low energy free-air chamber with the BIPM in the near future and have developed a new free-air chamber that can be used up to 300 kV. For ^{60}Co air kerma, they have a Shonka chamber that is traceable to the BIPM but plan to build their own primary standard chambers. They have acquired new staff to develop an extrapolation chamber for β-ray dosimetry.

Dr Chun (KRISS) was also pleased to have been invited as a Guest and reported that they are developing a graphite calorimeter as a standard for absorbed dose to water. They also have established a new mammography system.

11 APPENDIX C (CIPM MRA) CALIBRATION AND MEASUREMENT CAPABILITIES

Dr Webb reviewed the minutes from the November 2006 meeting of the CCRI RMO Working Group for Ionizing Radiation CMCs. The minutes are available to Members as document CCRI(I)/07-42 (access restricted).

Several laboratories that maintain standards for ionizing radiation have no direct links to an RMO. For them to be active participants in the CIPM MRA, they need to be designated as the NMI for ionizing radiation in their country. The CIPM has organized a series of workshops to help inform smaller laboratories of the guidelines and criteria regarding the CIPM MRA process.

The COOMET is planning a series of x-ray comparisons but because they are not using CCRI beam qualities, these will have to be supplementary, rather than key, comparisons.

Dr Webb drew attention to the thirteen recommendations arising from the meeting of the working group that would need to be addressed before the next meeting.

Dr Ross pointed out that, for the CMCs for most fields, the uncertainty statement reads “Relative expanded uncertainty (k = 2, level of confidence 95 %) in %: x”. However, for ionizing radiation CMCs, the statement is “Relative expanded uncertainty (k = 2, level of confidence not specified) in %: x”. He suggested that it was probably the intention of laboratories to indicate a confidence level of 95 %. Dr Thomas reviewed the spreadsheets for ionizing radiation and confirmed that the entry is “not specified” for the confidence interval. Dr Allisy-Roberts proposed that the question be referred to the CCRI RMOWG.

Dr Thomas then described the new search engine available for the KCDB and demonstrated some of its capabilities.

12 REPORTS FROM RMOS

12.1 APMP

Dr Saito gave a brief report on document CCRI(I)/07-50. He summarized the present APMP comparison schedule, the details of which can be found in Section 3 of CCRI(I)/07-50.

12.2 COOMET

Mrs Fedina drew attention to the report on COOMET activities which is available as document CCRI(I)/07-36.

12.3 EURAMET

Dr Csete (MKEH) reported on EURAMET activities as summarized in document CCRI(I)/07-37. EUROMET was not established as a legal entity, and as of May 2007, it was replaced with EURAMET, a legal body able to take advantage of EU funding opportunities. A European Metrology Research Programme (EMRP) has been formed and has identified several interesting challenges that will be the focus of collaborative research programs among the EU members. Proposals submitted will be considered and decisions made before the end of 2007.

Dr Kramer asked if the number of comparisons NMIs need to carry out might be reduced by establishing groupings of radiation qualities, similar to the groupings of radionuclides established by CCRI(II). Although some delegates thought this might be a useful concept, there was no consensus that it was necessary at this time. However, the CCRI RMOWG could be asked to consider this as a future possibility as there are presently over 100 radiation qualities listed in ISO documents.

12.4 SADCMET

Dr Mostert reported on SADCMET activities as summarized in document CCRI(I)/07-44. He pointed out that there is only one laboratory with dosimetry-related activities (NMISA). The NMISA participates in RMO comparisons with members of the APMP.

12.5 SIM

Mr Seltzer reported on SIM activities as summarized in document CCRI(I)/07-38.

The SIM reports on comparisons SIM.RI(I)-K1 and SIM.RI(I)-K4 are in the Draft B phase and are available as CCRI(I) documents (CCRI(I)/07-05 and CCRI(I)/07-07, access restricted).

The CNEA (Argentina) has proposed a comparison of orthovoltage x-rays and the NIST has agreed to act as the pilot laboratory and would submit the registration form to the Executive Secretary.

13 REPORTS FROM INTERNATIONAL MEMBERS AND OBSERVERS

13.1 IAEA

Dr Shortt, referring to document CCRI(I)/07-32, reviewed the IAEA dosimetry programme. The Quality System for the Agency's dosimetry laboratory was presented for review to a panel of experts from the RMOs. Their Quality System was approved by the JCRB panel of experts and subsequently accepted by the JCRB, supporting their CMCs in the KCDB.

The IAEA has undertaken a major expansion in their dosimetry facilities and now has four radiation bunkers. There is involvement in comparisons with several of the RMOs, including the APMP, EURAMET and the SIM.

The Agency carries out TLD dosimetry quality audits for interested radiotherapy clinics in cooperation with the WHO. Usually on their first participation, about 11 % of the participants have results lying outside acceptable limits. Unfortunately, about 5 % of the organizations do not have resources to improve their procedures and consequently have patients who are at risk through inadequate dosimetry.

The Agency's programme in high-dose dosimetry for radiation processing was terminated in 2005. Referred to as the International Dose Assurance Service (IDAS), it was based on alanine dosimetry and had been established in 1985. There were growing concerns about the reliability of the ESR spectrometer and external review panels recommended that the service be terminated.

13.2 ICRU

Referring to document CCRI(I)07/14, Mr Seltzer reported on recent activities by the ICRU. Dr DeLuca and Dr Wambersie have exchanged positions as Chairman and Vice-Chairman. Two reports are expected to be published in 2007. The first (*ICRU Report* 77) is on the elastic scattering of electrons and positrons while the second (*ICRU Report* 78) is on proton dosimetry for radiation therapy and is in essential agreement with TRS-398.

With regard to a suitable quantity that includes the biological effects of high-LET radiation, the ICRU is likely to recommend the quantity "isoeffective dose" with the SI unit of Gy. It will be recommended that both the absorbed dose and the isoeffective dose be reported for each treatment.

The 2005 CCRI(I) meeting had generated some questions that might be addressed by the ICRU, including the definitions of certain quantities including g, used to report the radiative loss. These points will be addressed in a planned revision of *ICRU Report* 60. Regarding clarification of the two quantities dose-area product and dose-length product used in diagnostic radiology, Mr Seltzer commented that there is an active Report Committee on Computed Tomography. The ICRU was also looking at the operational quantities for radiation protection.

13.3 IOMP

Prof. Svensson pointed out that the IOMP has 17 500 members in 76 countries. He reviewed the ESTRO-QUALity assurance network (EQUAL) for European radiotherapy centres. The participation level in the TLD audits is about 50 %.

He reviewed the current situation regarding charged particle therapy and pointed out that about 45 000 patients have been treated with protons and about 4000 with carbon ions. He emphasized the importance of avoiding dosimetry problems and wondered why nations are developing their own protocols rather that using internationally accepted protocols. Comments were made that measurement protocols can interface to national regulations and that it was important to use the correct protocol.

13.4 IRPA

No representative for the International Radiation Protection Association (IRPA) was in attendance and no report had been submitted.

14 PUBLICATIONS

14.1 *Metrologia* special issue on radiation dosimetry

The selection of articles and the proposed authors was presented (CCRI(I)/07-34, access restricted). All the authors have indicated their tentative acceptance to participate and manuscripts are due on 1 January 2008. Dr Sharpe will be guest editor for this special issue.

Dr Allisy-Roberts indicated that most BIPM reports dating from 1964 are now available to download from the BIPM website.

14.2 NMI bibliographies

Dr Allisy-Roberts thanked the participants for providing their updated bibliographies, all of which were available on the CCRI(I) website. This was seen as an important part of their membership of the CCRI(I). She asked each participant whether or not working documents they had provided for the meeting could be made publicly accessible. This request was made with the proviso that any material that would otherwise be published should not be open and that any material that had been given to the CCRI(I) in confidence would likewise remain restricted. Approval was then given by the NMIs for the appropriate working documents to be made openly available and these are available at CCRI(I) working documents.

15 CURRENT AND FUTURE CCR(I) MEMBERSHIP

Dr Allisy-Roberts presented a table of present CCRI(I) Members and Observers. She noted that the GUM (Poland) has not participated in recent meetings. Members agreed that an encouraging letter should be sent and a decision as to their status within the CCRI(I) be based on their response. She suggested that the BARC (India) should be encouraged to apply for Observer status in view of their involvement in comparisons. She asked Members to consider whether the IAEA should be encouraged to apply for Member status. After a brief discussion it was agreed that they should, and Dr Shortt agreed to raise the issue with the IAEA management.

The status of CCRI(I) working groups was also discussed.

Dr Aalbers has been Chairman of the Key Comparisons Working Group (KCWG(I)) but because of his recent retirement a new Chairman needs to be appointed. The following membership was approved: Dr Aalbers (Co-opted), Dr Allisy-Roberts (BIPM), Dr Buermann (PTB), Dr Burns (BIPM), Dr Ross (NRC), Dr Sharpe (Chairman, NPL), and Dr Webb (ARPANSA). It is expected that most of the working group activities can be conducted via e-mail.

It was decided that the present membership of the Brachytherapy Standards Working Group (BSWG(I)) was satisfactory. Members are: Dr Allisy-Roberts (Chairman, BIPM), Dr Burns (BIPM), Dr Douysset (LNHB), Ms Kessler (BIPM), Dr Mitch (NIST), Dr Sander (NPL), Dr Selbach (PTB), and Dr van Dijk (NMi).

Dr Maringer (BEV) suggested a working group on accelerator dosimetry. Drs Duane (NPL), McEwen (NRC), and Stucki (METAS) will work with Dr Maringer to formulate objectives for a possible working group.

It was agreed to disband the present Working Group on Air Kerma Correction Factors.

16 DATE OF THE NEXT MEETING

Members agreed that the next meeting should be held in May 2009. It will be preceded by a one-day meeting on brachytherapy standards. Dr Allisy-Roberts noted that 2009 marks the 50th anniversary of the CCRI and that plans will be made to recognize this milestone at the next CCRI(I) meeting.

17 CONCLUDING REMARKS

Prof. Moscati stated that he was impressed by the quality of the presentations. He pointed out that a final report must be ready for the CGPM in a few weeks. He encouraged Members to impress upon the management of their laboratories the importance of the work carried out by the

Consultative Committees and the BIPM. He noted that the workload of the BIPM has increased and that one way national laboratories can help out is by taking advantage of the possibility of making staff secondments to the BIPM.

Dr Sharpe closed the meeting. He thanked the participants for their open and frank discussions. He emphasized that the CCRI(I) was indebted to the BIPM, the Executive Secretary and the staff of the BIPM Ionizing Radiation section for the success of this meeting and to the *rapporteur* for the meeting report.

On behalf of the participants, Mr Seltzer thanked Dr Sharpe for his Chairmanship of the CCRI(I).

Carl Ross, *rapporteur*

Circulated November 2007

revised March 2009

APPENDIX R(I) 1.
Working documents submitted to the CCRI(I) at its 18th 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 at the restricted website.

Document CCRI(I)/	
07-00	Draft agenda, P.J. Allisy-Roberts, 2 pp. (access restricted)
07-01	Lawrence Livermore National Laboratory (United States) *et al*. — Compact accelerator concept for proton therapy (abstract), G. Caporaso *et al*., 1 p.
07-02	NMIJ/AIST (Japan), INER (Chinese Taipei). — Protocol for the bilateral comparison APMP.RI(I)-K2 of low-energy x-ray and mammography dosimetry standards between the NMIJ/AIST (Japan) and the INER (Chinese Taipei), T. Kurosawa, C.-H. Chu, 3 pp. (access restricted)
07-03	BIPM. — Progress report on absorbed dose calorimetry at the BIPM, S. Picard, D.T. Burns, P. Roger, 2 pp. (access restricted)
07-04	BIPM. — The evaluation of degrees of equivalence in regional dosimetry comparisons, D.T. Burns, P.J. Allisy-Roberts, 2 pp.
07-05	SIM. — Final report of the SIM ^{60}Co air kerma comparison, C.K. Ross, 20 pp. (access restricted)
07-06	ARPANSA (Australia). — Recent activities in measurement standards and dosimetry at ARPANSA, 2005-2007, D. Webb, D. Butler, C. Oliver, G. Ramanathan, 7 pp.
07-07	SIM. — Final report of the SIM ^{60}Co absorbed dose to water comparison, C.K. Ross, 19 pp. (access restricted)
07-08	BIPM. — Progress report on the BIPM standard for mammography, C. Kessler, P. Roger, D.T. Burns, 2 pp. (access restricted)
07-09	CMI (Czech Rep.). — Progress report on photon dosimetry at the CMI, V. Sochor, 3 pp.
07-10	METAS (Switzerland). — Recent activities in measurement standards and dosimetry at METAS, 2005-2007, G. Stucki, S. Gagnebin, D. Twerenbold, S. Vörös, 7 pp.
07-11	NIST (United States). — Update on NIST x-ray air-kerma standards and calibrations, M. O'Brien and S.M. Seltzer, 1 p.
07-12	NIST (United States). — Update on the NIST program for air kerma from ^{60}Co γ-ray beams, R. Minniti, 1 p.
07-13	NIST (United States). — Update on NIST β-particle dosimetry standards and calibrations, C.G. Soares, 2 pp.

Document
CCRI(I)/

07-14 NIST (United States). — Update on the NIST second-generation room-temperature water calorimeter, H. Chen-Mayer, R. Tosh, 3 pp.

07-15 NIST (United States). — Update on NIST radiation-processing (high-dose) dosimetry services, M.F. Desrosiers, J.M. Puhl, S.L. Cooper, 2 pp.

07-16 NIST (United States). — Update on NIST prostate-seed brachytherapy standards and calibrations, M.G. Mitch, S.M. Seltzer, 2 pp.

07-17 NIST (United States). — Recent dosimetry activities at the NIST, S.M. Seltzer, 22 pp.

07-18 NRC (Canada). — NRC activities and publications, 2005-2007, C.K. Ross, 17 pp.

07-19 ICRU. — ICRU Report activities, S.M. Seltzer, 1 p.

07-20 NMIJ/AIST (Japan). — Progress report on radiation dosimetry standards at the NMIJ/AIST (revised), N. Saito, T. Kurosawa, M. Kato, Y. Morishita, A. Nohtomi, N. Takata, 9 pp.

07-21 PTB (Germany). — Progress report of the [PTB] department `Fundamentals of Dosimetry`, L. Büermann, B. Großwendt, 5 pp.

07-22 PTB (Germany). — Progress report of the [PTB] department `Radiation Protection Dosimetry`, U. Ankerhold, R. Behrens, H. Dombrowski, 4 pp.

07-23 PTB (Germany). — Progress report of the [PTB] department `Dosimetry for Radiation Therapy`, M. Anton, K. Derikum, R.-P. Kapsch, H.-M. Kramer, A. Krauss, H.-J. Selbach, 6 pp.

07-24 PTB (Germany). — A cryogenic electrical substitution radiometer for hard x-rays, M. Gerlach, M. Krumrey, L. Cibik, P. Müller, G. Ulm, 4 pp. (access restricted)

07-25 LNE-LNHB (France). — Highlights of 2005 and 2006 at the LNE-LNHB, F. Delaunay, 4 pp.

07-26 NMi VSL (Netherlands). — Progress report on radiation dosimetry standards, facilities and related topics at NMi, 2005-2007, E. van Dijk, 3 pp.

07-27 BIPM. — Air-kerma determination using a variable-volume cavity standard, D.T. Burns, C. Kessler and P. Roger, 6 pp. (access restricted)

07-28 BIPM. — Status report on the BIPM standards for ^{60}Co γ radiation, D.T. Burns, C. Kessler, 3 pp. (access restricted)

07-29 ENEA-INMRI (Italy). — Activity at the ENEA-INMRI on photon and charged particle dosimetry, 2005-2007, R.F. Laitano, M. Pimpinella, M.P. Toni, 18 pp.

07-30 BIPM. — Dosimetry comparisons and calibrations at the BIPM, 2005-2007, P.J. Allisy-Roberts, D.T. Burns, C. Kessler, P. Roger, 7 pp.

07-31 CCRI(I) BSWG. — Brachytherapy Standards Working Group (BSWG) meeting notes, D.T. Burns, 2 pp. (access restricted)

07-32 IAEA. — IAEA Dosimetry and Medical Radiation Physics (DMRP) activities 2005-2006, K. Shortt, J. Izeweska, I.D. McLean, A. Meghzifene, S. Palm, S. Vatnitskiy, P. Bera, L. Czap, R. Girzikowsky, 20 pp.

07-33 NPL (United Kingdom). — Progress report on radiation dosimetry at NPL, April 2007, P. Sharpe and S. Duane, 8 pp.

07-34 CCRI(I). — *Metrologia* special issue on ionizing radiation dosimetry, P. Sharpe, P.J. Allisy-Roberts, 3 pp. (access restricted)

Document CCRI(I)/

07-35 VNIIM (Russian Fed.). — Recent activities in radiation dosimetry at the VNIIM, I.A. Kharitonov, N.D. Villevalde, A.V. Oborin, S.A. Fedina, V.I. Fominykh, I.I. Tsvetkov, 5 pp.

07-36 COOMET TC 1.9. — COOMET annual report TC 1.9 "Ionizing radiation and radioactivity", V. Yarina, 2 pp.

07-37 EUROMET. — EUROMET Ionising Radiation Technical Committee activities related to dosimetry, 2005-2007, I. Csete, 11 pp.

07-38 SIM. — Report of SIM laboratories to the CCRI(I), April 2007, L.R. Karam, 3 pp.

07-39 SIM. — Metrology Technical Working Group 6 Report to the SIM: Report of the 2nd meeting, L.R. Karam, 6 pp. (access restricted)

07-40 BEV (Germany). — BEV progress report 2005-2007 on research activities in radiation dosimetry standards and facilities, F.-J. Maringer, F. Gabris, W. Tiefenboeck, A. Steurer, A. Baumgartner, 4 pp.

07-41 OMH (Hungary). — Progress report on radiation dosimetry at the MKEH (OMH), I. Csete, 2 p.

07-42 CCRI RMO CMC WG. — Meeting report of the CCRI RMO Working Group for ionizing radiation CMCs – 2006, D. Webb, 11 pp. (access restricted)

07-43 NIM (P.R. China). — High-dose standardization study for γ-rays radiation processing at the NIM, ZHANG Yanli, GAO Junchen and YANG Yuandi, 7 pp.

07-44 SADCMET. — Recent SADCMET events in ionizing radiation, J. Mostert, 1 p.

07-45 NIST (United States). — Proposal for a NIST-sponsored high dose comparison of standards for absorbed dose to water from ^{60}Co gamma radiation, M.F. Desrosiers, J.M. Puhl, S.M. Seltzer, 2 pp. (access restricted)

07-46 BIPM. — Summary of the BIPM.RI(I)-K1 comparison for air kerma in ^{60}Co gamma radiation, P.J. Allisy-Roberts, D.T. Burns, 14 pp. (access restricted)

07-47 BIPM. — Extract from the BIPM Work Programme submitted to the CGPM for November 2007, A.J. Wallard, 6 pp. (access restricted)

07-48 APMP. — Presentation of the report on the regional key comparison on air kerma rate for ^{60}Co gamma-ray (APMP.RI(I)-K1), K.J. Chun, 21 pp. (access restricted)

07-49 NIM (P.R. China). — Progress in ^{60}Co γ-rays and x- rays air-kerma (exposure) standards at NIM, ZHANG Yanli, HU Jiacheng, YANG Xiaoyuan, TIAN Zhongqing, 8 pp. (access restricted)

07-50 APMP. — APMP/TCRI Activity Summary 2006, Y. Hino, 4 pp.

07-51 CIPM. — 23rd CGPM meeting Draft Resolution C, 1 p. (access restricted)

07-52 NMISA (South Africa). — Recent activities in radiation dosimetry at the NMISA, J. Mostert and Z. Msimang, 2 pp.

07-53 CCRI. — Report of the Absorbed Dose and Air Kerma Primary Standards Workshop, P.J. Allisy-Roberts, 3 pp. (access restricted)

Document
CCRI(I)/

07-54 BIPM. — Proposal for a change to the BIPM air-kerma standard for ^{60}Co, D.T. Burns, P.J. Allisy-Roberts, 2 pp. (access restricted)

07-55 CCRI(I). — Actions from the CCRI(I) May 2007 meeting, P.J. Allisy-Roberts, 5 pp. (access restricted)

07-56 CCRI(I). — Recommendations for the NMIs and the BIPM arising from the CCRI(I) meeting in May 2007, P.J. Allisy-Roberts, 1 p. (access restricted)

CONSULTATIVE COMMITTEE
FOR IONIZING RADIATION

Section II: Measurement of radionuclides
Report of the 19th Meeting
(23-25 May 2007)

Abstract

Section II (Measurement of radionuclides) of the Consultative Committee for Ionizing Radiation (CCRI) held its 19th meeting at the Pavillon de Breteuil (the BIPM headquarters), Sèvres, from 23 to 25 May 2007. The main discussions centred around the numerous activity comparisons under way and the present and future programmes of work of the six CCRI(II) Working Groups and the BIPM. Several new key comparison reference values were discussed and approved. The KCWG presented the evolution of the measurement methods grouping criteria for radionuclides to support CMCs, commonly known as the generic groupings table, and the NMIs were encouraged to use it and keep it up to date. The new Quality System for the SIR was described and the BIPM was congratulated on its implementation, and the CCRI(II) reported satisfaction with the overall BIPM work programme. The special issue of *Metrologia* on radionuclide metrology was reported to be on schedule. The BEV was proposed as a new Observer on the Section.

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

Section II (Measurement of radionuclides) of the Consultative Committee for Ionizing Radiation held its nineteenth meeting at the Pavillon de Breteuil (the BIPM headquarters), Sèvres, from 23 to 25 May 2007.

The following representatives of member organizations were present: D. Alexiev (ANSTO), C. Bobin (LNE-LNHB), F. Bochud (IRA), R. Broda (RC), M. Capogni (ENEA-INMRI), N. Coursol (LNE-LNHB), P. de Lavison (NPL), Y. Hino (NMIJ/AIST), H. Janβen (PTB), L. Karam (NIST), N.I. Karmalitsyn (VNIIM), J.-M. Los Arcos (CIEMAT), G. Moscati (President of the CCRI), T.S. Park (KRISS), W.W. Pereira (LNMRI/IRD), M. Sahagia (IFIN-HH), B.R.S. Simpson (Chairman of Section II CCRI, NMISA), J. Sochorová (CMI), M. Unterweger (NIST), A.J. Wallard (Director of the BIPM), U. Wätjen (IRMM), F. van Wyngaardt (CSIR-NML), A. Yunoki (NMIJ/AIST), Yang Yuandi (NIM, the first day).

Observers: W. de Vries (NMi VSL), U. Sansone (IAEA).

Guest: F.J. Maringer (BEV).

Also attending the meeting for all or part of the time: P.J. Allisy-Roberts (Executive Secretary of the CCRI), D.T. Burns, C. Michotte, S. Picard and G. Ratel (BIPM), C. Thomas (BIPM, KCDB coordinator).

Apologies for absence were received from: C.J. da Silva (LNMRI/IRD), L. Johansson (NPL), J.W. McLaren (NRC-INMS), L. Joseph (BARC), B.D. Michael (ICRU), P.H.S. Smith (IOMP), L. Szücs (MKEH), G. Winkler (IIK).

At the beginning of the second day, Prof. Yang Yuandi (NIM) was excused from the meeting to return to China in response to the sudden death of the Director of the NIM. The CCRI(II) offered its sincere condolences to all his colleagues at the NIM.

The Chairman, B.R.S. Simpson, welcomed the delegates, in particular those new to the CCRI, and asked those present to introduce themselves.

Prof. Wallard, Director of the BIPM, welcomed the assembled delegates and wished them a successful meeting. He remarked on the hurricane that had occurred the previous Sunday and hoped that none of the delegates had experienced difficulties with transport. He looked forward to talking to them individually during breaks.

Prof. Moscati, President of the CCRI, also welcomed the delegates and expressed his thanks to those present and to previous contributors. He asked for the Committee's advice on new trends in radionuclide metrology and on further work that might be needed due to changes in radionuclide production.

He stressed the importance of the work of the Section, to discuss problems and provide advice to the CIPM, to advise on the work programme of the BIPM for the dotation to be proposed to the CGPM and for the Metre Convention.

He noted that this would be his last attendance at the CCRI as he intended to resign during 2008, and he thanked the assembled company for their collaboration.

The meeting confirmed the appointment of Mr P. de Lavison (NPL) as *rapporteur*.

Dr Simpson related how the CCRI had been established in 1958, with Section II set up in 1969. The Committee was given responsibility for coordinating work in ionizing radiation carried out by the NMIs, in particular traceability to international standards. This is achieved through comparisons, and most importantly, since the introduction of the CIPM MRA, the key comparisons. The CCRI meetings monitor the progress of such comparisons and enable recommendations to be put forward to the CIPM to consider for the CGPM.

The Section meets every two years, and the laboratories that participate as Members are those recognized as being the most expert in the field, as demonstrated though research, publications and participation in comparisons. Section II oversees six Working Groups (WG): Key Comparisons Working Group (KCWG(II)); Uncertainties Working Group (UCWG(II)); Extension of the SIR to β-emitters using liquid scintillation (ESWG(II)); Realization of the becquerel (BqWG(II)); High-efficiency detection systems (HEWG(II)); Transfer instrument (TIWG(II)).

With some minor changes (bringing the KCWG report forward, inserting international reports at a new item of the agenda, and including a brief update on ICRM 2007), the agenda was agreed.

2 REPORT OF THE 19TH MEETING OF THE CCRI, INCLUDING THE 18TH MEETING OF THE CCRI(II) AND MATTERS ARISING NOT OTHERWISE ON THE AGENDA

Prof. Moscati gave a summary of the previous meeting, including a description of the main topics. He particularly noted the relation between the CCRI and the CIPM MRA, and the influence of key comparisons published in the BIPM Key Comparison Database (KCDB) in improving measurements, including their uncertainties. He said that the last meeting had been very productive, and hoped that this one would also bring good results.

The Chairman then reported on the twelve proposals from the previous meeting:

1. The table of “Measurement methods grouping criteria for radionuclides to support CMCs”, commonly known as the generic groupings table, had been finalized with some amendments.
2. Agreement had been reached on new updated Key Comparison Reference Values (KCRVs).
3. From 2006 only KCRVs based on absolute standardizations would be accepted, except for gases.
4. The workshop on uncertainties requested for 2006 had not been arranged.
5. Agreement had been reached to display relative KCDB results in terms of kBq/MBq.
6. Agreement had been reached that once the final comments on a Draft A report had been received, the first Draft B report could be started and the results would no longer be confidential.
7. The CCRI should create guidance notes on uncertainties – and hold a comparison exercise.

8. Dietmar Reher and Michael Woods could be invited personally to attend the uncertainties workshop.
9. The ^{35}S comparison could be brought forward to 2007 in place of ^{137}Cs.
10. The three SIM supplementary comparison exercises should be open to all RMOs.
11. Definitions of specific activity were agreed and forwarded to the IUPAC.
12. The proposal to create a transfer instrument for measuring short half-life radionuclides was approved.

Dr Simpson summarized the current state of comparison exercises and workshops. He stated that the generic groupings table had been produced to reduce the workload on NMIs in support of their CMCs, and that as a result of the table the comparison programme for the next ten years could run at one comparison per year. He noted that most of the nuclides chosen for the next decade are non-gamma-emitting, and pointed out that the RMOs can organize comparisons with gamma emitters in conjunction with the SIR to ensure the linkage to the KCRV. This was especially important as many earlier results would start to be phased out from 2008.

He described how a special Working Group had been established in 2003 to progress the *Metrologia* special issue. Suggestions had been presented and then discussed by the WG at a meeting held during the 2005 ICRM Conference.

He noted that 3200 CMC entries had been registered from the RMOs, covering a range of nuclides and matrix materials, and suggested that a set of typical matrices should be available in the regions.

3 REPORT OF CCRI(II) KEY COMPARISON WORKING GROUP (COORDINATOR: L. KARAM, NIST) (CCRI(II)/07-04)

The Coordinator recounted that three KCWG meetings had been held, in September 2005, November 2006, and May 2007. No specific recommendations were forthcoming at the 2005 meeting and from the 2006 meeting the requests and recommendations had centred on the generic groupings table, in particular the colour coding of entries. She explained the significance of the colour coding, and gave examples of $^{87}Sr^{m}$ and $^{95}Tc^{m}/^{95}Tc$ that need to be assigned. Not many comments had been received from members, and the Coordinator requested that delegates review the table, particularly for omissions.

A number of recommendations arose from the 2007 meeting:

1. The tritium comparison planned for 2007 needed to be delayed while laboratory refurbishment at the LNHB was completed. It was recommended that only tritiated water be measured.
2. Changes to the KCRVs were detailed.
3. A proposal was made that a comparison of ^{177}Lu should be held in 2007 if the ^{3}H comparison was delayed, and the NIST stated its willingness to pilot the comparison.
4. Delegates were asked to indicate their participation in a comparison of ^{223}Ra.

5. A draft of the IAEA comparison of radionuclides in soil, water and grass had been received, but not in time for discussion at the meeting. It would be discussed and approved electronically.
6. CENTIS-DMR (Cuba) had been unable to participate in the Rocky Flats comparison at that time due to difficulties with shipping samples. Third-party intervention could make this possible in a future comparison.
7. Changes to the generic groupings table were listed, and delegates were requested to review and comment on these, noting that this was a living document. It was pointed out that the tables were a tool to simplify the work of the NMIs with respect to CMC declarations.

It was proposed that all members should review the entries in the table and submit additional changes by the end of September 2007.

Discussion followed about the categorization of ^{22}Na in the tables, the difficulties associated with measurement methods, uncertainties and the effects of updating the branching ratios. It was agreed that the WG should review the entry for ^{22}Na, including uncertainties, and consider a change to the categorization and whether the current KCRV was valid.

The uncertainties associated with different methods for ^{75}Se were also discussed and the uncertainty for the TDCR/CIEMAT-NIST method was approved as 3 %. It was also approved that the entry for 4P/AP/BP/PH/AE/XR-LS-00-00-TD should be removed from the table and the other entries for ^{75}Se should be changed from red to yellow.

Apart from the decisions pending for ^{22}Na and ^{75}Se, the CCRI(II) approved all other recommendations of the KCWG for the generic groupings table.

Dr Simpson (NMISA) was proposed as a member of the KCWG rather than being *ex officio* and this was approved by the CCRI(II).

As Chairman he then proposed the following resolution, which was approved:

> "In view of the consequences on the traceability of CMCs, the CCRI(II) recommends that, before a colour is changed, or an uncertainty is reduced in the document "Measurement methods grouping criteria for radionuclides to support CMCs", the KCWG will check the CMC database to ensure that any laboratories that may be affected by the changes are notified one month in advance of the change. Note that this does not affect additions to the table."

It was noted that a laboratory should not amend its uncertainty simply because of a change in the table, as the values in the table indicate best capability.

4 BIPM.RI(II) KEY COMPARISONS

4.1 Current status of the SIR (CCRI(II)/07-22)

Dr Ratel presented a table detailing recent submissions and summarizing those since 1976. He described the provisional schedule for 2007, notably the ^{85}Kr ampoules to be distributed by the

LNE-LNHB, and presented stability data for the two SIR chambers. It was noted that the VNIIM needed to be added to the provisional schedule as it planned to send two ampoules.

4.1.1 Update on comparison reports

Dr Allisy-Roberts noted that the publication output for SIR reports had been slightly lower than in previous years, due to the effort required to implement the quality system and to comply with local legislation concerning holdings of radioactive material. However, sixteen reports had been published covering thirty results.

Five results from 2005 had not yet been published as the activity measurements were awaited from the NMIs. The ^{134}Cs, ^{133}Ba and ^{131}I reports would be the next priority as the ^{201}Tl and ^{237}Np reports had already been issued as Draft B reports. The ^{201}Tl report had been delayed to await a new submission from the NPL.

It was noted that the submission of ^{241}Am by the VNIIM would allow a link between the COOMET comparison and the SIR.

4.1.2 Consideration of new results for inclusion in certain KCRVs (CCRI(II)/07-12)

Dr Michotte presented the rules for KCRV data selection, notably that a value was derived from an unweighted mean and that only primary standardizations were now being included, with the exception of gas standards for which traceable ionization chamber results would need to be included.

She reported the new KCRVs published for ^{18}F, ^{60}Co, ^{67}Ga, ^{99}Tc ^{m}, ^{137}Cs, ^{139}Ce, and ^{222}Rn. The ^{67}Ga results were presented in detail, and it was noted that the lowest values were all measured by anti-coincidence methods. The apparent systematic deviation probably resulted from uncertainties in the decay scheme of the ^{67}Zn daughter. It was suggested that a new evaluation of the ^{67}Ga decay scheme would be important to obtain consistent results in the future.

Proposed changes to the KCRVs were then detailed for ^{22}Na, ^{51}Cr, ^{57}Co, ^{99}Tc^{m}, ^{109}Cd, ^{111}In, ^{134}Cs, ^{237}Np and ^{241}Am as shown in CCRI(II)/07-12. The CCRI(II) formally approved these proposals and that the ^{134}Cs value newly categorized as an outlier due to the change in the KCRV should be excluded from its value.

4.1.3 Removal of old results (pre-1977) from the KCDB

Dr Allisy-Roberts presented a revised table detailing how old results will be removed following the phasing process that had been previously agreed. Some twenty-five nuclides would be affected over the following year but the new results gained would outnumber old results lost; the total number of values in the KCDB rising from 457 to 484.

It was noted that if an NMI result drops out of the KCDB without being renewed, their CMCs would no longer be supported with this radionuclide comparison result. Their value could, however, remain as a contributor to the KCRV when deemed appropriate.

5 CCRI(II) AND RMO KEY COMPARISONS

5.1 Results and reports of activity measurements

5.1.1 Reports published since May 2005 (CCRI(II)/07-37)

Dr Allisy-Roberts referred delegates to BIPM radionuclide metrology publications May 2005 to May 2007 for details of the twenty reports that had been published.

5.1.2 Results for CCRI(II)-K2.Fe-55

Dr Ratel advised that the Draft A report had been issued two months earlier, and thanked those laboratories that had sent in results for their participation.

He described previous comparisons of this radionuclide in 1979 (CCRI(II)) and 1999 (EUROMET, now EURAMET), the latter showing significant bias depending on the method used. He described the decay scheme and noted that since the decision to start the current comparison two new values for the half-life had been released, although these had not been used.

Of the seventeen laboratories taking part, sixteen results were eligible for inclusion in the KCDB, and they showed remarkable homogeneity once the outliers had been removed. The BIPM and ENEA results showed the greatest deviation, though the ENEA result obtained during laboratory refurbishment was not an official outlier. The Draft A report had been issued; responses from participating laboratories were awaited before issuing Draft B.

A new comparison would be held between the BIPM, the ENEA and one of the successful laboratories, although this was unlikely to occur in 2007.

It was noted that the report of the 1979 comparison (D. Smith and M.J. Woods, NPL) was now available through the BIPM website.

5.1.3 Timetable for publication of reports for Am-241; Fe-55; Mn-54; I-125; P-32; Ir-192; Sr-89; Sr-90; Zn-65

Dr Allisy-Roberts described the current state of nine comparison reports, noting that those for ^{241}Am and ^{55}Fe were currently circulating in draft, and that the ^{89}Sr report would be the next to be issued. After discussion it was agreed that the remaining reports should be issued in the following order: ^{32}P, ^{125}I, ^{65}Zn, ^{54}Mn, ^{192}Ir, ^{90}Sr.

5.1.4 BIPM.RI(II)-K1.Np-237 and EUROMET.RI(II)-K2.Np-237

Dr Michotte explained the background to the ^{237}Np comparison and the reasons for the delay in publication of the results. The submissions had highlighted that the response of the SIR chamber was dependent on the mass of solution. The ampoule position did not seem to be critical, the response with respect to vertical position in the ionization chamber seeming to be quite homogeneous. In conclusion, the mass of solution was the critical factor and not the volume. Corrections are applied when ampoules with other than the standard mass are measured in the SIR.

A possible future project was proposed to study the relationship between activity and the mass or density of solution for all heavy nuclides.

Dr Allisy-Roberts asked for approval for the Draft B report for this comparison, as included in the working documents. The report was approved with some editorial changes, enabling it to proceed to publication.

5.2 Comparisons in progress

5.2.1 CCRI(II)-K2.Kr-85

Dr Ratel advised delegates that the gas ampoules had been filled, the activity being approximately 50 MBq in January 2007. They would be dispatched in June after measurement at the BIPM, and participants would have six months from receipt of the ampoules to submit results.

Dr Allisy-Roberts reminded participants that due to difficulties with despatching, they should be prepared in advance to receive sources.

5.2.2 BIPM.RI(II)-K4.Tc-99m and BIPM.RI(II)-K4.F-18

These comparisons were discussed in the Transfer Instrument Working Group Report under item 8.5.

5.2.3 APMP comparisons.

Dr Hino (NMIJ) reported on comparisons in the APMP region concerning ^{133}Ba, ^{134}Cs and ^{131}I.

The ^{134}Cs comparison had been carried out between the INER, LNE-LNHB, NMIJ, and the VNIIM, and the results demonstrated good agreement between the participants. A recommendation was made that the NMIJ and LNE-LNHB results should be used to link the INER and the VNIIM to the SIR. The comparison report was approved. The ^{133}Ba comparison was in progress and ^{131}I was proposed.

5.2.4 COOMET.RI(II)-K2.Am-241

Dr Karmalitsyn (VNIIM) detailed the recent COOMET comparison of ^{241}Am, presenting participants' results and the submission to the BIPM. Some discussion of uncertainty budget components followed.

Dr Allisy-Roberts requested approval from the delegates of the Draft B report for this COOMET comparison so that results could be included in the CCRI(II) key comparison Draft A. This approval was given.

6 PROGRESS WITH CCRI(II) SUPPLEMENTARY COMPARISONS

Dr Karam (NIST) reported progress with three SIM supplementary comparisons, noting that no progress had been made with the seaweed comparison (Draft B under development), that despatch difficulties had prevented the CENTIS-DMR (Cuba) from participating in the Rocky Flats soil comparison (Draft A under development) and that measurements were ongoing of shellfish flesh.

A draft report of a COOMET reference material comparison had been received. This comparison was being run with various laboratories, including the PTB and the MoE-ISR (Israel), and it was suggested that the results could be used in support of the CMCs. This would be discussed by the KCWG(II) in November 2007, after the September COOMET meeting.

Dr Wätjen (IRMM) proposed a new comparison for ^{40}K, ^{137}Cs and ^{90}Sr in a bilberry matrix. The NIST and the PTB expressed an interest in participating. Dr Wätjen agreed to supply more information to the KCWG(II), and Dr Allisy-Roberts would send the relevant application form.

Discussion followed about the measurement of reference materials in comparisons, and the possibility of learning from the experience of other Committees, such as the CCQM.

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

7.1 Recommendations for SIR comparisons (CCRI(II)/07-31)

Dr Michotte presented twenty-two radionuclides as listed in the current call for submissions to the SIR. The radionuclides were categorized according to the reliability of the KCRV with the aim of improving the current definitions.

Dr Simpson noted that results for some radionuclides had large uncertainties due to a limited knowledge of the decay scheme. Dr Allisy-Roberts requested that when laboratories carried out any radionuclide standardizations they consider submitting an ampoule to the SIR to improve the robustness of KCRV values.

7.2 Recommendations for CCRI(II) comparisons: Ten-year plan

Dr Allisy-Roberts presented the updated plan from 2005 (CCRI(II)/05-12) and discussion followed about the order and timing of future comparisons. The CCRI(II) comparisons held over the previous ten-year period included, ^{32}P, ^{54}Mn, ^{65}Zn, ^{89}Sr, ^{90}Sr, ^{90}Y, ^{125}I, ^{152}Eu, ^{192}Ir, ^{204}Tl, ^{238}Pu and ^{241}Am. Those proposed for the next ten-year period included ^{3}H, ^{35}S, ^{55}Fe, ^{85}Kr, ^{99}T^{m}, ^{109}Cd, ^{123}Te^{m}, ^{131}Cs, ^{133}Xe, ^{137}Cs, ^{222}Rn and ^{228}Th.

The following decisions were made for comparisons until 2011:

- ^{3}H – to be delayed to late 2008 as a result of the laboratory refurbishment at the LNE-LNHB;
- ^{35}S – to be delayed to 2009;
- ^{55}Fe – had been brought forward to 2005 and was now complete;
- ^{85}Kr – to be scheduled for 2007;
- ^{99}Tc^{m} – to be achieved via the SIR transfer instrument;
- ^{131}Cs – to be delayed until 2011.

A proposal to hold a ^{177}Lu comparison to be run by the NIST met with favour and it was agreed to hold this in 2008.

A discussion about a ^{223}Ra comparison to be run by the NIST ensued. Due to the difficulty of standardization, it was decided that this should be delayed to 2010 and only added to the plan once the category / standardization method had been agreed.

It was emphasized that the other radionuclides proposed in priority order, ^{131}Cs, ^{109}Cd, ^{123}Te^{m}, ^{137}Cs and ^{133}Xe, could be sent to the SIR as usual.

7.3 Registration of new RMO key comparisons

Dr Karam (NIST) reported that a number of SIM comparisons had been proposed, including ^{177}Lu, ^{85}Kr, ^{67}Ga, ^{22}Na and possibly ^{123}I. Dr Hino for the APMP said that there was much interest in ^{131}I comparisons and in parallel with the APMP.RI(II)-K2.I-131 many APMP laboratories would take part in the IAEA comparison for this radionuclide. It was noted that the SIM was still considering which short-lived nuclides to include, and that a limited subset of APMP NMIs were considering a comparison of ^{14}C that the KRISS would pilot.

Dr Allisy-Roberts advised delegates that for RMO comparisons to be linked to the KCDB they must be registered in advance, and that uncertainty budgets are also required for the results to be accepted.

8 WORKING GROUP REPORTS

8.1 Uncertainties Working Group (Coordinator: H. Janßen)

Dr Janßen (PTB) presented a short report on activities within the UCWG(II), noting that the scope had been limited due to the Coordinator having taken over other responsibilities at his own laboratory. Measurement uncertainties still needed to be established for some nuclides in the groupings table. Presentations had been made at the ICRM Conference in Oxford about correlation in the calibration of photon spectrometers. The WG had identified that correlations were generally being ignored.

Discussion followed about whether the 2005 proposals regarding mathematical models for uncertainties and the need for guidance notes were still relevant. With respect to correlations,

Dr Allisy-Roberts suggested that comparison participants should be required to submit the mathematical model for their uncertainties. Dr Janßen stated that the main purpose of doing this was to oblige people to think about the formulae they are using. It was agreed that this should be a major item on the agenda at the uncertainties workshops.

The Coordinator expressed his desire to withdraw from the post and asked the CCRI to appoint a successor. Following some discussion, Dr Unterweger was welcomed as the new Coordinator.

On behalf of the CCRI(II), Dr Allisy-Roberts thanked Dr Janßen for all his help with the discussions over radionuclide activity uncertainties in the past, and in preparing for the forthcoming uncertainties workshop.

It was announced that Dr Bobin (LNE-LNHB) would replace Dr Coursol, and Dr Johansson (NPL) would replace Mr Woods as members of the UCWG(II). Two new members were proposed and accepted: Dr Pommé (IRMM) and Dr Bochud (IRA). Dr Janßen indicated that he would propose a colleague from the PTB to replace him on the UCWG.

8.2 Realization of the becquerel Working Group (Coordinator: U. Wätgen)

Dr Wätjen (IRMM) summarized the discussions that had taken place at the BqWG meeting a few days earlier, explaining the main drivers for developing a reproducible ionization chamber system as: a potential leak of the pressurized SIR ionization chamber; a diminishing number of SIR ampoules; and the radiation protection problems associated with using old Ra reference sources. He stressed that by replacing the SIR equivalent activity A_e by an absolute current measurement (pA/MBq) traceable to the SI, the becquerel definition should be realizable. The project had been tested since late 2005, the major issues being related to the conductivity of the materials, the difficulty of machining within the demanding specifications and the long-term stability of the chamber itself.

It was expected that a further six months to one year would be required for these issues to be addressed, after which redesign and machining could take place. Production of a set of test chambers, enabling demonstration of reproducibility, would probably take two to three years. In response to the comment from the IRMM that it was unable to build the chambers, the BIPM and the CIEMAT each expressed their willingness to build a test chamber from the detailed design drawings that would be produced. The Coordinator responded to a suggestion that using calorimetry could be another approach to the problem by explaining that the concept was to copy the SIR rather than to develop a new method.

8.3 Extension of the SIR to β-emitters Using Liquid Scintillation System Working Group (Coordinator: J.M. Los Arcos)

Dr Los Arcos (CIEMAT) presented details of ESWG(II) efforts to develop a new liquid scintillation cocktail (XAN6040) and the tests carried out by the WG members. It was noted that this had been far from easy and that there were significant discrepancies between test results obtained by different laboratories. Despite these problems, the conclusion had been reached that if the new cocktail could be kept under normal environmental conditions it could be used more consistently in place of commercial products to meet the basic requirements for the long-term operation of the SIR extension.

Tests carried out at the CIEMAT had concentrated on intrinsic stability and repeatability of the proposed cocktail in comparison with commercial products. The degradation of various cocktails had been studied, sometimes with unexplained results. Two options for study remained open, one being further investigation of the new cocktail, and the other new developments of other formulations. Also presented was a suggested new measurement procedure for the ESIR that no longer needs to refer to the CIEMAT/NIST method nor a ^{3}H standard. The suggested procedure does not require evaluation/determination of *kB* nor $Q(E)$, does not rely on decay data values, and replaces efficiency modelling by an empirical approach based on the comparison of "apparent efficiency" values by simple linear fits.

Considerable discussion then followed about the properties of the new cocktail and the difficulties other laboratories had in replicating the results of the CIEMAT. The CIEMAT offered to send a guest worker to the BIPM towards the end of the year to assist in the cocktail production. This offer was accepted gratefully. Extensive discussion followed on the nature of the future solutions and particularly their preparation for pure beta emitters to be submitted to the SIR, how the results would be analysed and how the use of the XAN6040 cocktail in commercial instruments compared with standardizations using the TDCR method. Dr Cassette (LNE-LNHB) proposed using an external Compton source with the TDCR to avoid some of these problems.

Prof. Moscati thanked the Coordinator for the detailed presentation, noting that the project had been under way for a number of years and although some progress had been made, it seemed that there was still much work to be done. The Chairman queried the apparent efficiency parameter that was to be measured, suggesting that with the proposed method, the degradation of the scintillation cocktail and potential adsorption to the glass vial walls would introduce significant uncertainties. He proposed that the TDCR technique could be used as an alternative whereby an activity value independent of the scintillator quench state could be determined that would be specified relative to the NMI value. However, the Coordinator of the ESWG preferred using a reference to the efficiency. Dr Allisy-Roberts suggested that the protocol using XAN6040 should be run as planned while TDCR measurements should be run in parallel. This would enable an analysis of the best method to produce a KCRV. Dr Broda (RC) felt that further information was needed before a decision was made. He was unsure that the *kB* value would remain stable and supported the idea of using the two methods to compare the two sets of measurements, which ideally would give the same outcome. The CCRI(II) decided to let the BIPM choose whether or not to use both methods. The NMIs would send their standardized solution and the BIPM would add the scintillator and immediately make the LSC measurement so that adsorption should not be an issue. The IRMM, NIST, PTB, and the NMi agreed to send samples of ^{3}H to the BIPM as part of this project. Indeed, every NMI was invited to participate as part of the $^{3}H_2O$ comparison in 2008. To pilot this comparison, it was proposed to start with a ^{90}Sr comparison in autumn 2007.

8.4 High-efficiency Detection Systems Working Group (Coordinator: G. Winkler)

The Chairman reported that he had received an e-mail from the HEWG(II) Coordinator explaining that involvement in other work had left little time for metrological work and that the proposed *Monographie* on "High-efficiency photon detection systems" could not be finished before 2008/09.

Dr Maringer volunteered to join Prof. Winkler in writing this *Monographie* and this assistance was gratefully acknowledged.

8.5 Transfer Instrument Working Group (Coordinator: C. Michotte) (CCRI(II)/07-14)

The TIWG(II) had met in November 2005, since when e-mail correspondence had been sufficient and no other meeting had taken place. Dr Michotte described the development of the transfer instrument (TI) since the WG was set up in 2005, detailing, the choice of check source (Nb from the IRMM), the associated electronics, the needs for a brass liner, for shielding and the luggage for transport. Extensive Monte Carlo simulations and measurements of $^{99}Tc^{m}$ from the LNE-LNHB (including the ^{99}Mo impurity) had been carried out.

Current plans included further measurements and calculations to determine the response of the TI to ^{99}Mo, analysis of results and deduction of the linking factor between the TI and the SIR. The NIST would send an ampoule of ^{99}Mo to assist in this work. A set of lead shields would be prepared at the BIPM for permanent loan to the NMI participants. Dr Michotte would accompany the instrument when it was transported, to ensure consistent set-up and operation.

The NMIs wishing to participate in the BIPM.RI(II)-K4.Tc-99m comparison were identified as the ENEA, KRISS, NIST, NMISA, NMIJ, PTB, RC and the VNIIM, with the IFIN perhaps taking part at a later stage. Those laboratories close enough to the BIPM to submit $^{99}Tc^{m}$ were requested to do so even if they were scheduled to receive the TI in the future as this would help make the link to the SIR more robust. The CIEMAT volunteered to do this. It was noted that while the initial comparisons would be based on $^{99}Tc^{m}$, laboratories might well wish to measure other nuclides while the TI was on their site, such as ^{18}F in the BIPM.RI(II)-K4.F-18 comparison. Dr Michotte responded that this was indeed the future plan. The LNE-LNHB, NIST and NPL showed interest in a future ^{11}C comparison. The radionuclide ^{56}Mn was also mentioned. However the influence of *bremsstrahlung* and the effect of solution density should be studied in detail before starting to measure beta emitters with the TI.

9 CURRENT AND FUTURE BIPM PROGRAMME: DIRECTOR'S REPORT

Dr Allisy-Roberts reported on the work carried out at the BIPM since 2005, described the work to be undertaken up to 2008 when the current programme would end, and gave an outline of plans for the following work programme period from 2009 to 2012 and beyond.

The upgrading of the laboratory facilities that should have been completed in 2006 was not quite finished. There was still some work to be completed on the SIR electronics, including validation before it could be included in the Quality System. Although some progress was being made on the gamma spectrometry using the hyperpure Ge detector and on the TDCR systems, it was limited by the available staff resources at the BIPM. Dr Allisy-Roberts advised delegates that the BIPM is looking for a three-month to six-month secondment from another laboratory to calibrate the BIPM high-purity germanium detector.

Nuclear regulatory changes in France have affected the operations of the section, notably the European high-activity sealed sources (HASS) directive, which required a special decree for the BIPM ^{60}Co source. A subsequent decree has resulted in some declassification but still with a requirement to eliminate sources older than ten years. However, the BIPM has succeeded in gaining an exemption from this legislation for the SIR radium reference sources in spite of their age.

The brachytherapy dosimetry transfer system for ^{192}Ir sources has not progressed, again due to lack of available staff resource. A secondment would be sought to progress this work. Plans were also in hand to undertake a comparison of ^{125}I seeds in the coming year.

Dr Allisy-Roberts gave an overview of the knowledge transfer between the BIPM and the NMIs since the last meeting, detailing external publications and joint BIPM reports as well as the visits made by NMI personnel, as published in the annual report of the BIPM Director to the CIPM.

A major proposal was under way to install a linear accelerator at the BIPM. Setting up the project would cost approximately 2.3 M€, the majority of which would be for the building rather than the accelerator equipment. The CCRI would be making a recommendation to the CIPM on this project.

On a somewhat smaller scale, the BIPM had a project to identify a new supply of SIR ampoules as the existing stock was running uncomfortably low. As the BqWG(II) was also looking for a new supply of ampoules to be used for their project, it was proposed that both projects would benefit from collaboration. The discussion that followed highlighted the difficulties in finding a satisfactory replacement for the original NBS (NIST) ampoules used for the SIR.

Dr Allisy-Roberts reminded the delegates that the current programme was not fixed, and invited them to comment and propose modifications. The CCRI(II) approved the programme and the priorities as presented.

The question was raised as to the CCRI policy on external funding, and more specifically whether laboratories can ask for EU funding to support the BIPM objectives. In reply, Prof. Wallard stated that the BIPM was not eligible for Framework7 funding, but could collaborate with other laboratories applying to the EU; the BIPM had no intrinsic problem with laboratories applying for funding in such a way.

10 NMI RESEARCH PROJECTS

Ms van Wyngaardt (NMISA) presented a recent project described in CCRI(II)/07-29 to carry out a calibration check of radionuclide calibrators used for the activity measurement of ^{99}Tc^{m}. The work presented significant logistical challenges, as the calibrators in Durban are approximately 1600 km from the NMISA in Cape Town. The exercise was deemed a success, and identified problems with the calibration factor for one of the calibrator types, the Curiementor 2. The NPL reported a similar exercise in the United Kingdom of Great Britain and Northern Ireland which identified that manufacturers' calibration factors might be related to the vial type.

Mr de Lavison (NPL) presented a project, mentioned in the NPL report CCRI(II)/07-13, to develop a 200 litre soft-waste drum standard for the calibration of gamma spectrometers used

during nuclear decommissioning. Filled with spiked ion exchange resin to achieve a density of 300 kg m^{-3} and activity of 0.4 Bq g^{-1} for the radionuclides of interest, ^{241}Am, ^{137}Cs and ^{60}Co, this was compared with 50 g samples of crushed reactor cooling tower shipped during the 2007 NPL environmental proficiency test exercise. Dr Bochud (IRA) expressed an interest as decommissioning was also an issue in his country and the distribution of activity in the drum could introduce uncertainties.

Dr Unterweger (NIST) presented several highlights from the NIST report CCRI(II)/07-07 including new research efforts for standardizing ^{223}Ra, ^{68}Ge and ^{230}Th, updates on automated ionization chamber measurements and revival of the anticoincidence system (which will lead to more SIR submissions), research on medical therapy applications of ^{210}Po, new efforts on standards supporting the medical imaging PET/CT initiative which will quantify the results of PET images using activity standard anthropomorphic phantoms, and the successful expansion of the NIST quality system to cover the production of radioactive standard reference materials.

11 TRENDS AND FUTURE METROLOGICAL NEEDS

11.1 Roadmaps (CCRI(II)/07-28)

Dr Coursol (LNE-LNHB) presented current efforts within the European Union (EU) to have metrology identified as a research subject in the Framework7 funding scheme, noting that iMERA (implementing Metrology in the European Research Area) was set up specifically to demonstrate that the European laboratories could collaborate in research. She described the creation of European Research Area-Network (ERA-NET), and the background to the European Metrology Research Programme, and showed the detailed roadmaps created by the IR technical committee.

EURAMET had submitted a proposal, ERA-NET+ to the EU to the value of 43 M€, for research projects in four categories: Fundamental Constants, Health, Dimensional (Length) Metrology and Electromagnetics. Projects relating to ionizing radiation metrology will be submitted under the health category.

It was noted that coordination between the nineteen NMIs and designated institutes was crucial, as only one submission is possible in each of the four themes per country.

11.2 Workshops, comparisons and uncertainties

Dr Allisy-Roberts suggested that a joint workshop should be held on comparisons and uncertainties, perhaps including practical examples, advice on uncertainty budgets, etc.

Discussion followed about the content and timing of such a combined workshop. It was generally agreed that the workshop would not be for beginners, but would be an opportunity for laboratories that have been involved in comparisons to bring their experience to the table, to discuss lessons learned and suggest ways to improve future exercises. It was suggested that the workshop should be held in 2008, and timed to coincide with Working Group meetings. One of

its aims could be to come up with a training schedule for wider use, to take place at a major international conference such as ICRM 2009. The programme and dates for the workshop will be discussed with the WG Coordinators.

11.3 ICRM 2007 progress

Dr Simpson gave a brief overview of the non-scientific aspects of the forthcoming ICRM conference in Cape Town. He described the geography and background to Cape Town, the conference venue and its locale. Full details of the conference and technical programme were on the ICRM website.

12 REGIONAL REPORTS

12.1 RMO activities

Reports were submitted from the Regional Metrology Organizations by Dr Hino (APMP), Dr Karmalitsyn (COOMET), Dr Coursol (EURAMET), Dr Simpson (SADCMET) and Dr Karam (SIM).

APMP (CCRI(II)/07-30)

Dr Hino gave some details of the APMP annual meeting held the previous December. He noted that the CMCs for Thailand had been subjected to a provisional review prior to the approval of their Quality System. He reported that the APMP comparison report on ^{134}Cs activity measurements had been accepted for publication but the ^{131}I comparison needed to be re-submitted as problems had been experienced with the source.

COOMET (CCRI(II)/07-05)

Dr Karmalitsyn described the production of the volume sources containing ^{137}Cs, ^{152}Eu and ^{90}Y for the supplementary comparison. A COOMET key comparison for ^{137}Cs was proposed with the BelGIM, CENTIS-DMR, SMU, and the VNIIM as participants. The TC1.9 meeting had taken place the previous October.

EURAMET (CCRI(II)/07-28)

Dr Coursol presented Dr Csete's paper from the EURAMET (the former EUROMET) with three activity projects. She highlighted the ^{240}Pu project concerning α-emission probabilities and decay data which should be complete by the end of the year. The report on the ^{124}Sb project and comparison was expected in June 2007; although this had been listed as a supplementary comparison it could be converted to a key comparison as each participant could submit a

standardized ampoule to the SIR. She also reported that the CMCs from Slovakia had been submitted and the CMCs from Germany and Romania were in preparation.

SADCMET (CCRI(II)/07-24)

Dr Simpson reported that the only national metrology institute in the SADCMET undertaking ionizing radiation metrology is the NMISA (South Africa) but it is involved in RMO comparisons through being an associate member of the APMP.

SIM (CCRI(II)/07-16, CCRI(II)/07-17)

Dr Karam reported that of the five entities in the SIM, only four undertake radionuclide metrology. With regard to the CMCs, she stated that Quality System (QS) of the ININ (Mexico) was under review and the inter-RMO CMC review, currently with the EURAMET, should be complete before September 2007 when the QS should also be accepted. She requested that the ^{134}Cs key comparison report be published as soon as possible so that the new uncertainty for the CNEA (Argentina) CMC could be updated. She noted that there was no radionuclide metrology in Canada, all such measurements being traceable to the NIST, although the SIM had invited them to reconsider their position. Argentina, Brazil, Mexico and the United States of America had participated in recent comparisons.

12.2 RMOWG on IR CMCs (CCRI(II)/07-19)

The CCRI(II) accepted that CMCs would only be published if the relevant laboratory has a valid Quality Management System (QMS) in place; however, to save time, the CMC review process could start before approval of the QMS has been granted.

Dr Thomas (BIPM) reported that the KCDB had been redesigned on the BIPM website, notably references to appendices A, B and C have been made less obvious as these are not commonly understood outside the membership. This notation had been replaced by their full titles. There was a new text-based search engine enabling CMCs to be found using keywords (nuclides, techniques, etc.). The database contains hidden details of legacy CMCs which had been removed due to the lack of a valid QMS. These could be reinstated once the QMS are approved.

12.3 Progress on LNE-LNHB EUROMET project 721 for Zn-65 decay data measurement

The ^{65}Zn project was finished and had been published as a CEA report (*Rapport-CEA-R*-6081, 2005). A summary had been given at the 2005 ICRM conference referenced as *Applied Radiation and Isotopes* **64** (2006) 1396 in the conference proceedings. It was noted that the new data point fits very well with the SIR results.

12.4 Other supplementary comparisons to be registered

Dr Allisy-Roberts reminded the delegates to fill in the supplementary comparison registration form to enable such RMO comparisons to be registered in the KCDB.

13 INTERNATIONAL REPORTS

13.1 IAEA (CCRI(II)/07-35)

Dr Sansone (IAEA) reported the organization of two CCRI(II) supplementary comparisons in 2006. The soil, grass and water comparison (S4) has been completed with five NMI participants, and the first draft report was currently with all of the participants. Once approved it would then be submitted to the KCWG(II). The phosphogypsum comparison (S5) was under way with twelve participants; some NMIs having requested whether other local laboratories could participate. Dr Sansone thanked Dr Allisy-Roberts for her help with these comparisons. A feasibility study was in progress concerning the analysis of natural radionuclides in oil pipe scale from the Persian Gulf, which may lead to a further supplementary comparison.

13.2 ICRU (CCRI(II)/07-42)

In the absence of a representative of ICRU, no oral report was presented. The written report had also been submitted to and discussed at the CCRI(I).

14 PUBLICATIONS

Dr Allisy-Roberts demonstrated the new BIPM website search engine. It searches every single NMI website, not just pages on the BIPM site, and links directly to pages or documents published on the NMI sites. It can be accessed via http://search.bipm.org, but there is a search box on every page of the BIPM site that links directly.

All relevant documents relating to the Working Groups can be accessed on the BIPM website. Some areas are password-protected to restrict access by the general public when the reports are work in progress, or contain sensitive material. Anyone working at an NMI in a BIPM Member State can obtain the passwords from the BIPM.

14.1 *Metrologia* special issue

Dr Simpson gave an overview of the publication of the *Metrologia* special issue on Radionuclide Metrology, from its hesitant beginnings at the 2003 meeting to its present-day status. The papers that were still being completed were identified and the aim, keeping to the projected timeline, was to publish by the end of August 2007.

Dr Judge (NPL) expressed his thanks (*via* Mr de Lavison) to Dr Jeffrey Williams, BIPM Editor, for his work in managing the submitted papers. Dr Simpson and Dr Allisy-Roberts both thanked Dr Judge for his efforts in keeping the special issue on track. A joint editorial would be prepared by Dr Simpson and Dr Judge.

14.2 BIPM *Monographies* and future projects

Dr Allisy-Roberts demonstrated the link to the *BIPM Monographies* on the BIPM website and gave a summary of current progress. The next *Monographie* to be published will be on the SIR efficiency curves. Dr Michotte was currently working on this, and a draft was due. The plan was then to have a complete description of the SIR by Dr Ratel, high-efficiency counting by Prof. Winkler, and the appropriateness of carrier solutions by Dr M.-G. Iroulart following on from *Monographie 6*. Dr Karam noted that the NIST had been working on carrier solutions, and offered to contribute to this last *Monographie*.

Prof. Moscati advised the group that after publication of the issue, the papers would be freely available for download for a period of at least thirty days. He recommended announcing the publication widely to the radioactivity community.

14.3 CCRI(II) bibliographies

Dr Allisy-Roberts advised the delegates that recent publication lists in the field of radionuclide metrology were available in the CCRI(II) pages on the BIPM website. For major laboratories, these lists cover the period since the last CCRI meetings, while for those smaller laboratories a period of five years was more usual.

15 LABORATORY REPORTS

The following written reports had been submitted by the NMIs and were noted for the record, as most of their contents had been raised during earlier discussions: ANSTO (CCRI(II)/07-06); NIST (CCRI(II)/07-07); NMi (CCRI(II)/07-08); VNIIM (CCRI(II)/07-09); NIM (CCRI(II/07-11); NPL (CCRI(II)/07-13); LNMRI (CCRI(II)/07-21); KRISS (CCRI(II)/07-25); LNE-LNHB (CCRI(II)/07-26); IRMM (CCRI(II)/07-27); MKEH (CCRI(II)/07-36); RC (CCRI(II)/07-38); and IIK (CCRI(II)/07-40).

In addition to these reports, the following short presentations were made, to highlight the written reports from six other NMIs.

IFIN (CCRI(II)/07-03) – Dr Sahagia presented recent work at the IFIN, including improvements to equipment with a new 4πPC facility, the main areas of research on standardizations and nuclear decay measurements, participation in comparisons and the development of their Quality System with an external audit. She thanked the LNE-LNHB for their ongoing collaboration, and Dr Coursol for assistance with the CMCs submitted by the IFIN.

NMIJ (CCRI(II)/07-10) – Dr Yunoki presented recent work at the NMIJ, including participation in domestic ^{131}I and ^{99}Tc^{m} and international ^{85}Kr comparisons, the production of printed area sources, calibration services – notably an internet-based remote calibration service – and plans for the next two fiscal years.

CMI (CCRI(II)/07-15) – Dr Sochorová presented recent work at the CMI, including routine activities, international comparisons, digital coincidence counting techniques, TDCR developments, spectrometry, and decay data evaluation for $^{113}Sn^{m}$.

IRA (CCRI(II)/07-18) – Dr Bochud presented recent work at the IRA, including the development of TDCR equipment, standardization of $^{166}Ho^{m}$ for use as an ionization chamber check source to replace ^{137}Cs, and the application of Bayesian statistics. It was noted that the latter was a powerful tool, particularly for a rapidly decaying source in situations having low counts, even though the calculations required took almost as long as the measurements themselves.

NMISA (CCRI(II)/07-23) – Dr Simpson presented recent work at the NMISA, particularly the international workload of meetings, conferences and comparisons. He highlighted his involvement in the ICRM 2007 and his pleasure in working on the special issue of *Metrologia*. The standardization of ^{99}Mo was mentioned, as was the possibility of taking part in a ^{63}Ni comparison.

ENEA (CCRI(II)/07-39) – Dr Capogni presented recent work at the ENEA, including standardizations of ^{125}I, ^{64}Cu and ^{188}Re, and the acquisition of a well-type ionization chamber for use as a secondary standard transfer instrument with hospitals in Italy. He described ^{222}Rn standards, reference chambers and the related national quality assurance programme and calibrations for seven ^{18}F production centres using a portable ionization chamber.

16 CCRI(II) MEMBERSHIP ISSUES

16.1 CCRI Membership

The BEV had applied for Observer status of the CCRI(II) and Dr Maringer was invited to describe the work of the BEV, and of the Ionizing Radiation section in particular, in support of this application. He included details of the laboratory's equipment and facilities and its current aims and tasks. He focused on the development of Monte Carlo simulations of ionization chambers for the calculation of calibration and correction factors, and of an open-window large-area proportional counter as a primary standard for surface particle emanation rate.

Following his presentation, Dr Allisy-Roberts reiterated for the delegates the criteria for membership of the CCRI, that the laboratory should be an NMI or Designated Institute, that it be active in research (demonstrated through publications), that it participates in comparisons and be active in the CCRI(II). She presented the current status of Members and Observers on the CCRI(II). Prof. Moscati remarked that it is the CIPM that decides on whether an application merits full member status, or observer status for laboratories developing towards membership.

Following a closed discussion about the BEV application, the CCRI(II) endorsed the President's proposal to recommend to the CIPM Observer status of the CCRI(II) for the BEV.

It was noted that the BARC had been unable to attend the CCRI(II) meeting, and an application for membership had not been submitted. It was also noted that the CNEA, although it does not have a record in the publications database, is active in comparisons and should be encouraged to

apply. Dr Karam agreed to contact Dr Margarita Saravi about the possibility of the CNEA becoming an Observer of the CCRI(II), dependent on a publications list being sent to Dr Allisy-Roberts.

16.2 Working Group membership

Dr Allisy-Roberts reminded the delegates that Dr Simpson has become a full member of the KCWG, that Dr Bochud and Dr Pommé are to join the UCWG(II) and that Dr Janßen will propose a new member for the UCWG.

The Working Group Coordinators were requested, on behalf of the CIPM, to send a list of participants on their WG to Dr Allisy-Roberts (and to Dr Simpson *ex officio*). They were also requested to send their WG remit, being a statement describing a defined outcome for the WG and the timescale under which it operates.

The WG Coordinators were reminded that their report to the CCRI was crucial, and that any informal reports between CCRI meetings should be sent to the Executive Secretary in order to keep the Committee informed. It was noted that the CCRI President reports to the CIPM, and therefore ultimately to the CGPM.

17 DATE OF THE NEXT MEETING

The date of the next meeting was provisionally scheduled for May 2009; the precise date to be decided by the CIPM. The year 2009 will be the 50th anniversary of the first CCRI meeting (then known as the CCEMRI) and some special arrangements will be made to celebrate this, including inviting some of the early members.

Dr Simpson thanked Dr Janßen for having been UCWG(II) Coordinator for the last six years, during which period much had been achieved, notably the development of the measurement methods grouping criteria for radionuclides to support CMCs, commonly known as the generic groupings table.

Dr Coursol reported that this would be her last attendance at the CCRI(II) as a representative of the LNE-LNHB and the Chairman thanked her for all her input over the years.

Prof. Moscati concluded the meeting by remarking that, as President of the CCRI, he served as the connection to the CIPM and so also for the NMIs that were represented at the meeting, and that in reporting to the CIPM he would be relying on the expertise of the CCRI(II) Chairpersons, the Executive Secretary and the CCRI(II) Members. He was impressed with the research efforts of participants and the positive effect that the various Working Groups have had on comparisons, uncertainties, Quality Systems and the other work of the NMIs.

He was particularly pleased with the successful conclusion of the *Metrologia* special issue, believing that it would raise the profile of the CCRI(II) at CGPM, which he stressed was important for promoting cooperation between the metrology laboratories. He thanked the Section II Chairman, *rapporteur,* Working Group Coordinators and all the CCRI(II) Members

for their input to the CCRI(II) meetings. He also thanked the Executive Secretary and staff of the Ionizing Radiation Section of the BIPM who support the work and direction of the Committee.

Prof. Moscati reported that he would be taking the IR Section work programme to the CGPM in October, at which he would present highlights from the various NMI reports, for which he thanked the delegates, and he sincerely hoped that these would receive the support that he felt the work of the CCRI(II) deserved. He requested that delegates promote the work of the BIPM within their NMI administration to help the budget discussions for the BIPM work programme. He stressed the importance of the Metre Convention and international organizations such as the BIPM in international relations, noting the significant contribution made through the CIPM MRA by the NMIs and the BIPM.

Finally he expressed his pleasure in the work of the CCRI(II) and the BIPM and said that his time as CCRI President had been very rewarding.

P. de Lavison, *rapporteur*

Revised March 2009

APPENDIX R(II) 1.
Working documents submitted to the CCRI(II) at its 19th 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 at the restricted website.

Document CCRI(II)/	
07-00	Draft agenda, 3 pp. (access restricted)
07-01	CCRI(II) KCWG, CCRI(II) UCWG. — Grouping criteria for radionuclides to support CMCs, L. Karam, 7 pp. (access restricted)
07-02	BEV (Austria). — Application for observer status of the Consultative Committee for Ionizing Radiation, Section II, A. Leitner, 3 pp. (access restricted)
07-03	IFIN-HH (Romania). — Radionuclide Metrology Laboratory Report (2005-2007), M. Sahagia, 6 pp.
07-04	CCRI(II) KCWG. — Report of the CCRI(II) Key Comparison Working Group, L.R. Karam, 7 pp.
07-05	COOMET. — Annual Report of Chairperson of COOMET TC 1.9 “Ionizing radiation and radioactivity”, V. Yarina, 2 pp.
07-06	ANSTO (Australia). — Report to the CCRI - 2007, D. Alexiev, L. Mo, M.J. Qin, M. Smith, L. Bignell, 2 pp.
07-07	NIST (United States). — Radioactivity Group Technical Activities 2006, L.R. Karam, 42 pp.
07-08	NMi VSL (The Netherlands). — Progress on the NMi standards for radioactivity measurements, W. de Vries, 2 pp.
07-09	VNIIM (Russian Fed.). — Progress report of VNIIM in radionuclide metrology, I.A. Kharitonov, N.I. Karmalitsyn, 3 pp.
07-10	NMIJ/AIST (Japan). — Progress report of NMIJ/AIST in radionuclide metrology (2005-2007), A. Yunoki, 2 pp.
07-11	NIM (P.R. China). — NIM Report to the CCRI(II) Meeting 2007, YANG Yuandi, 4 pp.
07-12	BIPM. — Update of KCRVs for the BIPM.RI(II)-K1 key comparison series, C. Michotte, 5 pp.
07-13	NPL (United Kingdom). — NPL Report to the CCRI(II) meeting 2007, P. de Lavison, L. Johansson, 3 pp.
07-14	CCRI(II) TI WG. — Report of the CCRI(II) Transfer Instrument Working Group (TI WG), C. Michotte, 7 pp.
07-15	CMI (Czech Rep.). — Recent Activities in Activity Measurement at the Czech Metrology Institute, P. Dryák, J. Sochorová, P. Auerbach, M. Havelka, P. Kovár, 2 pp.

Document CCRI(II)/

07-16 SIM. — Report of SIM Laboratories to the CCRI (Section II, measurement of radionuclides), L.R. Karam, 3 pp.

07-17 SIM. — Metrology (Technical) Working Group 6 – Ionizing Radiation and Radioactivity Report of 2nd meeting to the SIM, D.M. Gilliam, L.R. Karam, 6 pp.

07-18 IRA-METAS (Switzerland). — Report to the CCRI(II) 2007 meeting, F.O. Bochud, 2 pp.

07-19 CCRI RMO WG. — Meeting of the CCRI RMO Working Group for Ionizing Radiation CMCs 2006, D. Webb, 11 pp. (access restricted)

07-20 BIPM, PTB (Germany), IRMM (Belgium), NPL (United Kingdom). — BIPM comparison BIPM.RI(II)-K1. Np-237 of activity measurements of the radionuclide ^{237}Np and links for the 1998 regional comparison EUROMET.RI(II)-K2.Np-237, G. Ratel, C. Michotte, H. Janßen, K. Kossert, G. Sibbens, M.J. Woods, S. Judge, 16 pp. (access restricted)

07-21 IRD/LNMRI (Spain). — Radionuclide Report 2005/2006, C. da Silva, 3 pp.

07-22 BIPM. — International Reference System for activity measurements of gamma-ray emitting nuclides (SIR), G. Ratel, 9 pp.

07-23 NMISA (South Africa). — Review of the activities at the National Metrology Institute of South Africa, B.R.S. Simpson, W.M. Van Wyngaardt, 2 pp.

07-24 SADCMET. — Recent SADCMET events in ionizing radiation, J. Mostert, 1 p.

07-25 KRISS (Rep. of Korea). — Progress Report on Radionuclide Metrology (2005-2007), T.S. Park, 4 pp.

07-26 LNE-LNBH (France). — Progress report related to Radionuclide Metrology, N. Coursol, 7 pp.

07-27 IRMM (Belgium). — Laboratory Report 2005-2007, U. Wätjen, 3 pp.

07-28 EUROMET. — Report on the EUROMET Ionising Radiation Technical Committee activities 2005-2007, I. Csete, 12 pp.

07-29 NMISA (South Africa). — Calibration check of radionuclide calibrators used for activity measurement of ^{99m}Tc, F. van Wyngaardt, B.R.S. Simpson, 3 pp.

07-30 APMP. — Report of the 22nd APMP General Assembly, Delhi 2006, Y. Hino, 4 pp.

07-31 BIPM. — Call for SIR submissions to improve the KCRVs, C. Michotte, 1 p.

07-32 BIPM. — Current status of SIR (2005) and 2006/7 submissions and reports, P.J. Allisy-Roberts, 1 p. (access restricted)

07-33 BIPM. — Phasing of published KCDB results for radionuclide measurements at end 2007, P.J. Allisy-Roberts, 1 p. (access restricted)

07-34 NMIJ/AIST (Japan), LNHB (France), INER (Chinese Taipei), VNIIM (Russian Fed.). — APMP comparison of the activity measurements of Cs-134, Y. Hino, M. Moune, M.C. Yuen, I.A. Kharitonov, 5 pp. (access restricted)

07-35 IAEA. — Review of the activities of the Reference Material Group of the IAEA's Seibersdorf Laboratories (2006-2007), U. Sansone, A. Shakhashiro, 8 pp.

07-36 MKEH (Hungary). — Progress Report on Radionuclide Metrology (2005-2007), L. Szücs, 2 pp.

07-37 BIPM. — BIPM radionuclide metrology publications since May 2005, P.J. Allisy-Roberts, 3 pp.

Document CCRI(II)/

07-38 IAE/POLATOM(Poland). — Review of activity (2005-2007), R. Broda, 2 pp.

07-39 ENEA-INMRI (Italy). — Report to the CCRI Section II on the activity carried out at the ENEA-INMRI on radionuclide measurements in the period 2005-2007, M. Capogni, P. De Felice, 9 pp.

07-40 IIK (Austria). — Summary of the research program related to radionuclide metrology for the years 2006 and 2007, G. Winkler, 3 pp.

07-41 VNIIM (Russian Fed.), BelGIM (Belarus), CENTIS-DMR (Cuba). — Measurement of the Activity Concentration of the Radionuclide Am-241 in a Solution – COOMET Project No. 359/RU/06, I.A. Kharitonov, A.V. Zanevsky, V. Milevski, A. Ivaniukovich, P.O. Verdecia, Y.M. León, 6 pp. (access restricted)

07-42 ICRU. — ICRU Report Activities, S.M. Seltzer, 1 p. (also document CCRI(I)/07-19)

07-43 CCRI(II) UC WG. — Report of the CCRI(II) Measurement Uncertainties Working Group (2005-2007), H. Janßen, 2 pp. (access restricted)

07-44 IFIN-HH (Romania). — Radionuclide Metrology Laboratory Report: May 2005 – May 2007, M. Sahagia, 12 pp. (access restricted)

07-45 NMIJ/AIST (Japan). — Progress report of NMIJ/AIST in Radionuclide Metrology 2007, A. Yunoki, Y. Sato, Y. Unno, Y. Hino, K. Kudo, 5 pp. (access restricted)

07-46 CMI (Czech Rep.). — Recent Activities in Activity Measurement at the CMI, P. Dryák, J. Sochorová, P. Auerbach, M. Havelka, P. Kovář, 11 pp. (access restricted)

07-47 NMISA (South Africa). — Calibration check of radionuclide calibrators used for activity measurement of ^{99m}Tc, F. van Wyngaardt, 8 pp. (access restricted)

07-48 ENEA-INMRI (Italy). — Report to the CCRI Section II on the activity carried out at the ENEA-INMRI on radionuclide measurements in the period 2005-2007, M. Capogni, 27 pp. (access restricted)

07-49 IRA-METAS (Switzerland). — Status report of IRA-METAS, F. Bochud, Y. Nedjadi, P. Spring, J.-P. Laedermann, C. Bailat, 12 pp. (access restricted)

07-50 IRMM (Belgium). — Working Group Report: Realization of the becquerel at the basic level, U. Wätjen, 3 pp.

07-51 IRMM (Belgium). — Working Group Report: Realization of the becquerel at the basic level (Power Point presentation), U. Wätjen, 20 pp. (access restricted)

07-52 CCRI(II) ES WG. — Extension of the SIR Working Group: Report to the CCRI(II) Meeting 2007, J.M. Los Arcos, 10 pp. (access restricted)

07-53 LMRI-CIEMAT (Spain). — Presentation of the Extension of SIR Working Group (Power Point presentation), J.M. Los Arcos, 57 pp. (access restricted)

07-54 BIPM. — Presentation of proposal for KCRV updates, C. Michotte, 20 pp. (access restricted)

07-55 NIST (United States). — Requests to the CCRI(II) from the KCWG(II) meeting 17 November 2006, L. Karam, 7 pp. (access restricted)

07-56 NIST (United States). — Addendum to grouping criteria for radionuclides to support CMCs (CCRI(II)/05-04), L. Karam, 2 pp. (access restricted)

CONSULTATIVE COMMITTEE
FOR IONIZING RADIATION

Section III: Neutron measurements
Report of the 17th Meeting
(29-31 May 2007)

Abstract

Section III (Neutron measurements) of the Consultative Committee for Ionizing Radiation (CCRI) held its 17th meeting at the Pavillon de Breteuil, (the BIPM headquarters), Sèvres, from 29 to 31 May 2007. Two seminars were given: "*Evolution of neutron source strength measurements intercomparisons*" and "*Future challenges in neutron metrology*". Final reports for two completed key comparisons, fast neutron fluence rate and neutron source emission rate, were nearing completion. The final report for a key comparison at 24.5 keV carried out in the 1990s was due to be prepared by the end of 2007. A key comparison of thermal neutron fluence rate measurements was in progress and running well. Two supplementary comparisons led by EURAMET but also involving other RMOs were discussed. These involve survey meter calibrations and neutron fluence rate measurements in the range 15.5 MeV to 19 MeV. 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. The KRISS (Rep. of Korea), satisfied the CCRI(III) that they now fulfilled all the criteria for membership and would be proposed as such to the CIPM. The CIEMAT was invited to apply for Observer status.

1 OPENING OF THE MEETING; APPROVAL OF THE AGENDA; APPOINTMENT OF A RAPPORTEUR

Section III (Neutron measurements) of the Consultative Committee for Ionizing Radiation held its 17th meeting at the Pavillon de Breteuil (the BIPM headquarters), Sèvres, from 29 to 31 May 2007.

The following were present: J.-M. Bordy (LNE-LNHB), M.S. Dewey (NIST), V. Gressier (LNE-IRSN), H. Harano (NMIJ/AIST), M. Kralík (CMI), G. Lövestam (IRMM), N.N. Moisseev (VNIIM), G. Moscati (President of the CCRI), R. Nolte (PTB), W.W. Pereira (LNMRI/IRD), N. Roberts (NPL), D.J. Thomas (Chairman of Section III, NPL), A.J. Wallard (Director of the BIPM), Zhang Hui (NIM).

Observers: M. Kellett (IAEA), H. Park (KRISS).

Guests: J.M. Los Arcos (CIEMAT).

Members of the BIPM who attended all or part of the meeting: P.J. Allisy-Roberts (Executive Secretary of the CCRI), S. Picard, and C. Thomas (KCDB coordinator).

Apologies: Chen Jun (CIAE), A.L. Nichols (IAEA), U.V. Phadnis (BARC), A. Wambersie (ICRU), Ye Hongsheng (CIAE).

Prof. Wallard, Director of the BIPM, and Prof. Moscati, President of the CCRI, welcomed the participants.

Dr Thomas, chairing a Section III meeting for the first time, introduced himself and invited all present to do likewise.

Dr Dewey from the NIST was appointed *rapporteur* of the meeting.

The participants were informed that seminars would be given by Mr Moisseev from the VNIIM on "*Evolution of neutron source strength measurements intercomparisons*" and by Dr Klein, recently retired from the PTB, on "*Future challenges in neutron metrology*".

2 REPORT OF THE 19TH MEETING OF THE CCRI, AND MATTERS ARISING FROM THE 16TH MEETING OF THE CCRI(III), 2005

Prof. Moscati referred delegates to the published proceedings of the 19th meeting of the CCRI and the associated Section meetings.

3 CCRI(III) COMPARISONS

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

Dr Nolte from the PTB gave a report on the comparison CCRI(III)-K10, whose current status was "Report in progress, Draft B" with the title "International Key Comparison of Neutron Fluence Measurements in Monoenergetic Neutron Fields". The results were fixed at the end of 2003, although the CIAE, NPL and the VNIIM later produced new results that were in better agreement − in some cases significantly better − with the key comparison reference value (KCRV). These new results could not be used because they arrived after the cut-off date (2003). The acceptability of Draft B to the participants was being assessed. The authors of the report concluded that improved response functions for fluence measuring devices, and more careful attention to uncertainty budgets, will be important for future measurements. The delegates were reminded that, in general, key comparisons become obsolete ten years after the last measurement.

3.2 CCRI(III)-K9.AmBe: neutron emission rate (Pilot NPL)

Mr Roberts from the NPL gave a report on the comparison CCRI(III)-K.9.AmBe, whose current status was "Report in progress, Draft A" with the title "International Comparison of Measurements of Neutron Source Emission Rates (1999-2005)". A preliminary version of the Draft B report had been mailed to all participants for their comments. One delegate noted that it had become more difficult to send sources such as the one used in the comparison around the world. The largest consistent subset method was used to obtain a KCRV. According to this method and the data to hand, values from the CIAE and LNE-LNHB were classified as outliers and not used to obtain a KCRV. Both laboratories later presented revised values that were much closer to the KCRV. The final relative uncertainty on the proposed KCRV was 0.25 %, smaller than the likely uncertainty on the correction required for fast neutron capture by oxygen. Most of the participants used the ENDF/B-VI cross-sections to derive this correction; however the LMNRI, NIST and possibly the CIAE did not. The difference owing to this choice can be as large as 0.5 %. There was considerable discussion about how to proceed. Finally it was suggested that those groups that did not use ENDF/B-VI cross-sections should revise their oxygen numbers using ENDF/B-VI and transmit new values to the NPL as soon as possible. The CMI, KRISS and VNIIM measured the anisotropy of the source in addition to its emission rate. Section III felt that this result should be published in a journal such as *Nuclear Instruments and Methods*. The NPL will carry out the anisotropy measurement as well. It was noted that in order to publish these results, uncertainty budgets must be provided.

3.3 CCRI(III)-K8: thermal neutron fluence rate (Pilot PTB)

Dr Nolte reported on the status of the comparison CCRI(III)-K8, which had started in November 2006 and was running as expected. A minor problem with the stability of the high-voltage display had been solved. The two groups that had carried out measurements reported no problems (NMIJ, NPL). The LNMRI and VNIIM expressed a wish to join this comparison as full participants.

3.4 CCRI(III)-K1: neutron fluence rate at 24.5 keV (Pilot NPL)

These measurements were carried out from 1993 to 1996. The data were quite promising because all the employed techniques were in agreement. There was a Draft A report, but it was not complete. Dr Klein, Dr Thomas and the BIPM agreed to try to generate a Draft B report. Four remaining issues were identified: (1) an uncertainty budget was needed from the NIST; (2) the credibility of the VNIIM uncertainty, which was half that of the others; (3) the best value to quote when more than one method of neutron production was used (it was felt that the weighted mean should be satisfactory here); and (4) whether the new CIAE values and uncertainties were acceptable, since expanding its uncertainties after Draft A (Dr Klein felt that they were). It was very important to generate a KCRV from this effort because the IEC standard that covers testing of survey meters, IEC 61005, "Radiation protection instrumentation – Neutron ambient dose equivalent (rate) meters", requires a response measurement in the range $1 < E_n < 50$ keV. To ensure that the KCRV resulting from this comparison remains valid beyond its normal expiration date, a proposal to extend the validity of the CCRI(III)-K1 comparison was drafted for the CIPM (see Recommendation R 2(2007), page 18). Section III agreed to have a Draft B report completed by the end of 2007.

3.5 Future needs for comparisons

Considerable discussion took place about possible ways of conducting comparisons for monoenergetic neutrons with energies between 144 keV and 14.6 MeV. There were two typical two modes of operation: (1) circulate instrument(s) thereby requiring each participating laboratory to produce and measure fluences; or (2) the pilot laboratory produces one or more fluences and each participating laboratory comes to measure these fluences. In practice the first method has proved to be very problematic as each laboratory must learn to operate unfamiliar instrument(s). This also tended to be a long and drawn-out exercise. Therefore it was recommended that fewer energies should be measured if this approach were to be taken and that the protocols should be more detailed. By 2011 a new comparison protocol will be necessary in this energy range. Several laboratories can produce neutron fluences in this range, including a new facility at Cadarache, France. Particular interest was expressed in measurements at 2.5 MeV and 8 MeV. Producing 8 MeV neutron fields seems to be a challenge.

There was also interest, expressed by the CMI, in a comparison using electronic personal neutron dosimeters that have recently become available. These devices tend to have a fast neutron response (from a hydrogenous layer on a diode) and also sometimes a thermal neutron response (from the presence of a material such as lithium in close contact with a diode) that can be read electronically. It was suggested that such a dosimeter, or a selection of such dosimeters, should be circulated to participants who will then make measurements in unmoderated AmBe or ^{252}Cf fields. Such a comparison would test the ability of each laboratory to deal with room scatter. The International Standard ISO 8529 "Reference neutron radiations", recommends that these devices are calibrated on a phantom at 75 cm from the source in a facility which is large enough that the scatter can be neglected. In smaller rooms a distance of 50 cm is given as an alternative. A comparison would test whether the assumption about scatter is valid for individual laboratories.

Others suggested that such a comparison might not be necessary. In the ensuing debate, delegates were reminded that there were six ways to justify a CMC:

1. results of key and supplementary comparisons;
2. documented results of past CC, RMO or other comparisons (including bilateral);
3. knowledge of technical activities by other NMIs, including publications;
4. on-site peer-assessment reports;
5. active participation in RMO projects;
6. other available knowledge and experience.

There were no volunteers as the pilot laboratory for a comparison.

Electronic personal neutron dosimeters are important for workers, therefore most countries will have rules for their calibration, although, for example, the new electronic devices may not yet be licensed for use in the United States of America. A suggestion was made to investigate the practice of private companies, although they probably do not strive for the highest accuracy.

4 RMO COMPARISONS

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

Dr Gressier from the IRSN reported on the status of the comparison EUROMET.RI(III)-S1, which has faced severe problems with instruments. A spherical Harwell monitor model N91 was currently being repaired following a power supply problem. The repair was expected to be completed in June 2007. It was noted that the measurements made to date should be acceptable. This exercise has extended over a number of years and the participants who have made measurements, in some cases several years ago, would like to receive a summary of where things stand without revealing the results. This could be done with a provisional Draft A report containing only relative results, which Dr Gressier was asked to prepare. A decision needs to be made on the future of this comparison.

4.2 EUROMET.RI(III)-S2: comparison of neutron fluence rate at 15.5 MeV to 19 MeV, EUROMET-project #822 (Pilot PTB)

Dr Nolte reported on the status of the comparison EUROMET.RI(III)-S2. All the measurements had been carried out and a detailed analysis of the results was in progress. A preliminary examination of the data showed reasonable agreement between the participants and uncertainties that were consistent with the experimental results.

4.3 Other RMO comparisons

No additional comparisons were discussed.

4.4 Future needs (RMO key or supplementary comparisons)

Dr Allisy-Roberts requested that she be kept informed of any RMO comparisons being planned. These comparisons must be registered to be valid under the CIPM MRA.

5 THE CIPM MRA (MUTUAL RECOGNITION ARRANGEMENT)

5.1 RMO CMC review group report

Dr Kralik reported that EURAMET (the former EUROMET) had not discussed neutron measurements in recent meetings and he felt that CCRI(III) was the proper forum for discussions on neutron calibrations. It was noted that CCRI(III) had not covered dosimeters before. The EURAMET had previously covered these devices for ambient and personal dose equivalent. If CCRI(III) were to take on this responsibility, a EURAMET "neutrons" section might not be needed. Some delegates wondered how different countries treat survey meters versus personal dosimeters. The report was noted for the record.

5.2 RMO activities: APMP; COOMET; EURAMET; SIM

Dr Harano reported on APMP activity (CCRI(III)/07-15); Mr Moisseev on the COOMET (CCRI(III)/07-01); and Dr Dewey on the SIM (CCRI(III)/07-03). There was no report on the EURAMET.

5.3 KCDB: Appendix C submissions (neutron CMCs, approved and under review)

There being no specific CMCs to consider, Dr Allisy-Roberts presented the new BIPM search engine. The progress of each NMI's CMCs could be followed, and customers could find CMCs more easily.

6 EXCHANGE OF INFORMATION ON WORK IN PROGRESS AT THE PARTICIPANT INSTITUTES

6.1 LNMRI/IRD (CCRI(III)/07-16)

Dr Pereira discussed recent developments and the status of neutron measurements at the LNMRI/IRD. Their neutron group has recently added two new staff members, thereby doubling the number of permanent staff.

6.2 VNIIM (CCRI(III)/07-02)

Mr Moisseev presented a seminar on the "*Evolution of neutron source strength measurements intercomparisons"*, which meticulously reviewed the history of these comparisons starting in the early 1950s and continuing through CCRI(III)-K8, which includes measurements made during 2000–2005. In his review of fifty years of experience, three facts were striking: (1) all laboratories have converged on one measurement method (the Mn-bath method); (2) the spread in results remains fixed at about 4 %; and (3) there is a tendency for the ratio of the results from any two laboratories to remain constant but different from the value 1.0. Taking into account the various corrections that have been instituted over the years to correct for systematic effects, Mr Moisseev concluded that the problem probably stems from measurement procedures and/or corrections made for neutron absorption in the source material. Further, if the goal were the most accurate measurement of the neutron emission rate then a new absolute method should be developed, whereas if consistency among the results were required then it would be simpler and cheaper to develop an artificial measurement standard of neutron source strength.

6.3 CMI

Dr Kralík discussed recent progress in neutron metrology at the CMI, which has developed a new Bonner sphere set based on passive thermal neutron sensors that will allow measurements in pulsed neutron fields.

6.4 IRMM (CCRI(III)/07-17)

Dr Lövestam discussed recent activities of the IRMM Neutron Physics Unit. Both of its neutron-producing accelerators, a 7 MV Van de Graaff and a 150 MeV electron linear accelerator are subject to continual upgrading. New in-house software allowed for real-time calculations of neutron spectra from Bonner sphere data. A new neutron spectrometer based on neutron activation of metal discs had a detection limit as low as a few neutrons per cm^2 per second. Finally, the Euratom Transnational Access programme had to date allowed eighteen neutron metrology projects from eight European countries to be carried out at this facility.

6.5 IRSN (CCRI(III)/07-08)

Dr Gressier discussed recent developments in neutron metrology at the IRSN. Their new AMANDE accelerator facility opened for business in April 2007. It provides monoenergetic neutron fields within the energy range from a few keV up to 20 MeV. A new reference long counter was being constructed that will determine the fluence of the monoenergetic neutron fields at AMANDE. Pulsed beams were soon to become available, allowing for time of flight measurements.

6.6 NIM (CCRI(III)/07-14)

Dr Zhang spoke about activities of the NIM in the field of neutron metrology. A new neutron irradiation facility had been constructed, and plans were under way to build a neutron spectrometer and a new Mn-bath system. The NIM planned to begin taking part in international comparisons.

6.7 NIST (CCRI(III)/07-12)

Dr Dewey discussed neutron standards work at the NIST, which had calibrated a low fluence 14 MeV neutron field produced by a recently purchased neutron generator. This could be used to transfer the calibration to other neutron generators and to calibrate neutron dosimeters. The NIST had also acquired a Rospec neutron spectrometer that could be used to quantitatively assess the room scatter of calibrated neutron fields. It had first been necessary to assist the vendor in solving a problem causing this commercially available spectrometer to give incorrect values for thermal and epithermal neutron fluence rates.

6.8 NMIJ/AIST (CCRI(III)/07-09)

Dr Harano reported on recent developments in neutron standardization at the NMIJ/AIST. New standard neutron fields at 2.5 MeV to 3 MeV, 8.0 MeV, 19 MeV and 27 keV had been or were being developed. A collaborative effort with the JAEA may lead to additional fields at 45 MeV, 60 MeV and 75 MeV. A novel small-sized thermal neutron detector using optical fibres had been developed with its sensitivity to gamma radiation actively suppressed.

6.9 NPL (CCRI(III)/07-10)

Dr Thomas reported on recent developments in neutron metrology at the NPL, where a new highly upgraded Mn-bath system was being brought online. Work was continuing to extend monoenergetic neutron standards to higher and lower energies than currently offered, and to improve and extend the range of neutron spectrometers available for field or laboratory measurements.

6.10 PTB (CCRI(III)/07-21, access restricted)

Dr Nolte discussed activities in the fields of neutron metrology and dosimetry at the PTB, which had applied neutron metrology measurement techniques to projects with external partners. One highlight was the successful operation of the PTB scintillation spectrometer at the AXDEX-Upgrade Tokamak at the Max-Planck Institute for Plasma Physics in Garching, Germany. By measuring a spectral neutron distribution, the ion temperature could be deduced. This was a versatile alternative to bulky magnetic recoil proton spectrometers in fusion diagnostics. Both the PTB's Van de Graaff accelerator and cyclotron are subject to continual upgrading.

6.11 IAEA

Dr Kellett spoke about the research activities of the IAEA nuclear data section, with emphasis on the evaluated data files supported by the IAEA.

6.12 KRISS (CCRI(III)/07-13)

Dr Park reviewed the activities of the KRISS in the field of neutron metrology. A Bonner sphere spectrometer (BSS) had been developed, which the KRISS has used to characterize the laboratory's radionuclide sources, the ambient fields at a nuclear power plant and a 50 MeV cyclotron facility. It was planned to extend the range of the BSS up to 200 MeV.

6.13 CIEMAT

Dr Los Arcos presented the activities of the dosimetry laboratory. A new facility that includes a Mn-bath, an irradiation room, neutron generators and a storage room was being built.

7 TRENDS AND FUTURE NEEDS IN NEUTRON METROLOGY

Dr Klein's seminar on "*Future challenges in neutron metrology*" pointed out exciting new challenges that will come from fusion experiments, including the International Tokamak Experimental Reactor (ITER), laser-based ion and neutron sources, high-energy accelerators, and demands for better neutron cross-section standards. To meet these challenges, better-characterized neutron yield monitors and spectrometers and new neutron fields, new cross-section measurements, and meaningful comparisons extending to E_n = 200 MeV will be needed. Dr Klein further proposed that Section III should study and recommend data sets to be used for the characterization of reference instruments and methods.

8 SPECIAL ISSUE OF *METROLOGIA* – IDENTIFICATION OF GUEST EDITOR AND EDITORIAL COMMITTEE

The Editor of *Metrologia* has asked each Section of the CCRI for a special edition. For Section III this would deal with neutron metrology. There was widespread support for this idea because there is no modern reference in the field. The special edition would consist of a collection of separate papers, each of which must stand alone. A preliminary table of contents including potential authors was distributed to the delegates (CCRI(III)/07-19, access restricted). Each item was reviewed, with particular note made of the choice of first author (also known as lead author). The following changes were made: (1) Dr Harano was added to item #3 (neutron emission rate of sources); (2) Dr Dewey was added to item #4 (flux density of thermal neutron beams); (3) Dr Akira Uritani may no longer be available for item #5 (fluence rate of mono-energetic neutron fields) and so it was suggested that another scientist from the NMIJ/AIST should be added; and (4) the IRMM wished to be added to items #5 and #6 (primary and secondary standards). As it currently appeared, item #8 (summary and conclusion) would probably not be suitable as a stand-alone paper; therefore additional material should be added. It was envisioned that this issue of *Metrologia* would contain between 150 and 170 pages. A time frame was suggested according to which it would appear in spring 2009. To accomplish this, refereed papers would have to be submitted to *Metrologia* by the end of 2008, implying effective final drafts available by summer 2008. As a first step, lead authors were requested to produce more detailed outlines. Dr Thomas would try to make arrangements for a document website for the authors to use (possibly hosted by the BIPM). It was suggested that Section III should agree a table of contents within three months and produce draft papers by the end of 2007. It was agreed that deadlines were necessary and that the end product would be very useful and widely applied.

9 FUTURE MEMBERSHIP OF THE CCRI(III)

The Executive Secretary described the criteria for membership. In recognition of the fact that the KRISS had now participated in a key comparison and thus satisfied all the criteria for membership, the delegates proposed that the KRISS be supported at the CIPM to become a full Member of the CCRI(III). The CIEMAT was invited to apply for Observer status.

10 FUTURE CHAIRMAN OF THE CCRI(III)

As Dr Thomas was willing to remain as Chairman, Section III requested that he should continue.

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

A brief report was given on current activity at the BIPM. The new metrology search engine was presented with its very powerful capability to search the websites of all NMIs and return results in a nicely structured way, allowing them to be sorted and viewed as desired.

12 CCRI(III) WORKING DOCUMENT STATUS

A suggestion was made to make the protocols available in the KCDB. This idea, which met with general approval, would be implemented.

13 OTHER BUSINESS

The delegates authorized most of the working documents submitted by laboratories and institutions to be transferred to the open-access area of the CCRI website. A suggestion was made that presentations from the laboratories be given in several groups rather than all being given at the same session. It was further suggested that the written and associated oral presentations should focus more on metrology, especially as there were few opportunities to discuss neutron metrology outside the CCRI.

14 DATE OF THE NEXT MEETING

The next meeting was scheduled for May 2009, to coincide with the 50th anniversary of the first CCRI meeting.

M.S. Dewey, *rapporteur*

revised March 2009

APPENDIX R(III) 1.
Working documents submitted to the CCRI(III) at its 17th 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 at the restricted website.

Document
CCRI(III)/

07-00 Draft agenda, 2 pp. (access restricted)

07-01 COOMET. — Annual Report of Chairperson of COOMET TC 1.9 "Ionizing radiation and radioactivity", V. Yarina, 2 pp.

07-02 VNIIM (Russian Fed.). — Evolution of neutron source strength measurements intercomparisons, N.N. Moiseev, I.A. Kharitonov, 3 pp.

07-03 SIM. — Report of SIM Laboratories to the CCRI (Section III, neutron measurements), L.R. Karam, 2 pp.

07-04 SIM. — Metrology (Technical) Working Group 6 – Ionizing Radiation and Radioactivity (MWG 6) Report of the 2nd Meeting 2005 to the SIM, D.M. Gillian, L. Karam, 6 pp.

07-05 BIPM. — Future Challenges in Neutron Metrology, H. Klein, 1 p.

07-06 CIAE (P.R. China). — Development of thermal neutron reference radiation field at CIAE, BAO Zongyu, CHEN Jun, YUE Qian, WANG Jianqin, 6 pp. (access restricted)

07-07 CCRI RMO WG. — Meeting of CCRI RMO Working Group for Ionizing Radiation CMCs, D. Webb, 11 pp. (access restricted)

07-08 IRSN (France). — Recent developments in neutron metrology at the Institute for Radiological Protection and Nuclear Safety (IRSN), V. Gressier, V. Lacoste, L. Lebreton, 13 pp.

07-09 NMIJ/AIST (Japan). — Recent activities in neutron standardization at NMIJ/AIST, H. Harano, T. Matsumoto, A. Uritani, K. Kudo, 8 pp.

07-10 NPL (United Kingdom). — Recent developments in neutron metrology at the National Physical Laboratory, D. Thomas, S. Ashley, A. Bennett, S. Cheema, N. Hawkes, N. Horwood, L. Jones, P. Kolkowski, C. McKay, N. Roberts, G. Taylor, 10 pp.

07-11 CIAE (P.R. China), CMI (Czech Rep.), KRISS (Rep. of Korea), LNMRI (Brazil), LNE-LNHB (France), NIST (United States), NPL (United Kingdom), VNIIM (Russian Fed.). — International Comparison of Measurements of Neutron Source Emission Rate (1999-2005) – CCRI(III)-K9, Z. Wang, Y. Liu, Q. Wang, X. Chen, H. Luo, C. Rong, M. Kràlik, H. Park, K.O. Choi, W.W. Pereira, E.S. da Fonseca, P. Cassette, M.S. Dewey, N.J. Roberts, L.N. Jones, N.N. Moisseev, I.A. Kharitonov, 23 pp. (access restricted)

Document
CCRI(III)/

07-12 NIST (United States). — Technical activities of the NIST Neutron Interactions and Dosimetry Group 2006, M.S. Dewey *et al*., 27 pp.

07-13 KRISS (Rep. of Korea). — Recent activities of the neutron standardization at KRISS, H. Park, 6 pp.

07-14 NIM (P.R. China). — Neutron Metrology at the National Institute of Metrology (NIM), ZHANG Hui, 5 pp.

07-15 APMP. — APMP/TCRI Activity Summary Report of the 22nd APMP General Assembly, Delhi 2006, Y. Hino, 4 pp.

07-16 LNMRI/IRD (Brazil). — Recent activities in neutron metrology at the LNMRI/IRD, W.W. Pereira, 3 pp. (access restricted)

07-17 EC-JRC-IRMM (Belgium). — Recent Developments in Neutron Measurements at EC-JRC-IRMM, G. Lövestam, 6 pp.

07-18 PTB (Germany). — International Key Comparison of Neutron Fluence Measurements in Mono-energetic Neutron Fields – CCRI(III)-K10, R. Nolte, 65 pp. (access restricted)

07-19 CCRI(III). — Neutron Metrology, H. Klein, D. Thomas, 2 pp. (access restricted)

07-20 PTB (Germany). — Status of the comparison exercises CCRI(III)-K8 and EUROMET.RI(III)-S2, R. Nolte, 1 p. (access restricted)

07-21 PTB (Germany). — Recent Developments in Neutron Metrology, Neutron Dosimetry and Related Areas at the Physikalisch-Technische Bundesanstalt (PTB), R. Nolte, 4 pp. (access restricted)

07-22 PTB (Germany). — Future Challenges in Neutron Metrology, H. Klein, 48 pp. (access restricted)

07-23 LMRI-CIEMAT (Spain). — Neutron Standards Laboratory Project: Current Status, J.M. Los Arcos, 17 pp. (access restricted)