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NETWORK OF
SECONDARY
STANDARD
DOSIMETRY
LABORATORIES

SSDL NEWSLETTER

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of the SSDL Network

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CONTENTS

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EDITORIAL NOTE

Professor Pedro Andreo, Head of the IAEA Dosimetry and Medical Radiation Physics Section, left the Agency in November 2000 and returned to Sweden (University of Stockholm-Karolinska Institute/Karolinska Hospital). Appointed in January 1995, he initiated his activities as Section Head in August 1995. His main research activities aimed at improving the dosimetry of therapeutic beams and the use of Monte Carlo calculations for radiotherapy treatment planning. He was co-author of the IAEA Code of Practice, TRS-277, and of the new International Code of Practice, TRS-398 (in press). Undoubtedly, he has made a significant contribution to the activities of the IAEA in dosimetry and medical radiation physics. He kindly prepared "a farewell message to the SSDL Network Members", which is reproduced on pages 2 and 3 of this issue of the SSDL Newsletter.

The first article of this issue of the SSDL Newsletter is the report of the 9th SSDL Scientific Committee Meeting held from 13–17 November 2000. The editor wishes to draw the readers' attention to recommendations xviii, xxi and xxvi of the Scientific Committee, to evaluate the potential needs of SSDLs for the audit and calibration services in diagnostic radiology, brachytherapy and nuclear medicine metrology. For that purpose, the Secretariat of the IAEA/WHO network is preparing a survey form to be sent to all SSDLs of the network. It is hoped that the network members will fill in the questionnaire and return it to the Secretariat as soon as possible.

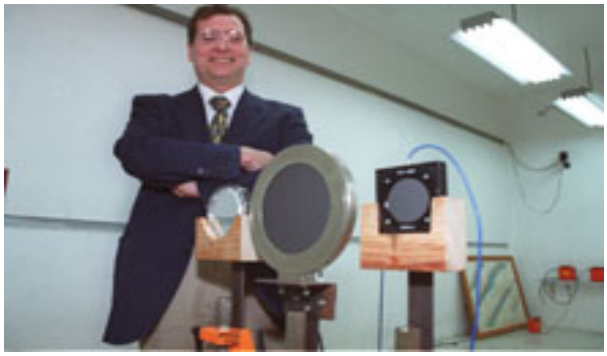
The second article is a technical note prepared by the staff of the Dosimetry and Medical Radiation Physics Section that deals with the "effect of humidity on measurements with a well type chamber". Those SSDL members possessing a well type chamber are encouraged to conduct similar frequent constancy checks and submit their contributions to the editor for publication in a forthcoming issue of the Newsletter. Contributions will be duly acknowledged.

The third article is a report of the Second Research Co-ordination Meeting (RCM) for the Co-ordinated Research Project (CRP E2.40.07) on "the development of a quality assurance programme for radiation therapy dosimetry in developing countries", held at IAEA Headquarters from 4–8 December 2000. The aim of the CRP is to establish national Quality Assurance (QA) networks for external quality audits for radiotherapy hospitals in developing countries. This is done by setting up national External Audit Groups (EAGs) with laboratory backup for operating TLD audits for radiotherapy dosimetry. The main results achieved under this CRP are included in the report.

A new SSDL has recently joined our Network: the Laboratory of State Dosimetry Standards of the Belarussian State Institute of Metrology (Gosstandart). The SSDL has been added to the database of the IAEA/WHO Network of SSDLs; the SSDLs are listed on pages 33-34, under Member Laboratories of the IAEA/WHO Network of SSDLs.

FAREWELL MESSAGE TO THE SSDL NETWORK MEMBERS

Pedro Andreo



This issue of the SSDL Newsletter coincides with the end of my service as Section Head of the Dosimetry and Medical Radiation Physics (DMRP) Section at the Agency, following my resignation and subsequent return to the Chair of Medical Radiation Physics at the University of Stockholm, Sweden. It has been a satisfaction and a great privilege to serve as the IAEA Co-Secretary of the IAEA/WHO SSDL Network from 1995 through 2000. Thanks to the dedication and hard work of the DMRP Section and staff members of many SSDLs, these have been among the most exciting and productive years of my scientific career. Looking retrospectively, I believe that during this period we have all together initiated so many new projects and achieved so many important accomplishments in the field of dosimetry and metrology of ionizing radiation that I could not possibly mention them all in this note. I would like to summarize here the most significant.

In providing support to the operation of the SSDL Network we have

- Supported the expansion of the Network to its present 73 Laboratory Members and 20 Affiliated Members.
- Implemented, as a regular service, the intercomparison of NK and ND,w calibration factors at the radiotherapy level, as supplied by the SSDLs, and made more strict the conditions of acceptability of the results.
- Developed standards for brachytherapy and x-ray dosimetry (notably mammography) in order to provide new calibration services to the SSDL Members. These have been complemented by publications in the two fields containing dosimetry recommendations, being mainly IAEA TECDOCs.
- Implemented a TLD service for the SSDLs for audits in the field of radiation protection.
- Developed laboratory Quality Assurance manuals that serve as a model for those to be developed at SSDLs.
- Developed and published as an IAEA document a Charter for the SSDL Network.
- Signed the Mutual Recognition of National Measurement Standards and of the Calibration and Measurement Certificates issued by National Metrology Institutes (the Mutual Recognition Arrangement, MRA) for the IAEA/WHO Network of SSDLs, following the invitation from the Bureau International des Poids et Mesures (BIPM).
- Enhanced communication with the members of the Network and their representation at the biennial meetings of the Consultative Committee for Ionizing Radiation (Section I) at the BIPM.
- Enhanced communication and active cooperation with Regional Metrology Organizations like EUROMET, SIM (the Americas), etc.
- Developed further the scientific level of the SSDL Newsletter, encouraged greater participation from the SSDLs in the contributions to the Newsletter, and established its regular publication twice annually.
- Expanded the equipment at the IAEA Dosimetry Laboratory to support the activities of the SSDL Network.

In support of the TLD service to radiotherapy institutions we have

- Doubled the number of radiotherapy beams checked worldwide, now around 500 per year.
- Improved follow-up actions for institutions with results outside acceptable levels by implementing second blind tests and increasing the number of deviations resolved.
- Established a system of on-site visits for the resolution of anomalies.
- Improved the return rate of TLDs to the Agency for evaluation, from approximately 60% to more than 90%.

- Enhanced the quality assurance of the TLD system with the increased participation of the BIPM and PSDLs.
- Improved communication with other TLD-based networks and established the mutual exchange of dosimeters as a regular practice.
- Contributed to establishing national TLD-based networks in developing countries.
- Developed Quality Assurance manuals that serve as a model for other TLD networks.
- Improved the level of communication with the users of the TLD service by designing new reports for the results and developing new instructions.
- Expanded the equipment at the IAEA Dosimetry Laboratory.

In support of the dissemination of dosimetry techniques and medical radiation physics we have

- Published the International Codes of Practice TRS-381 (for plane-parallel chambers), TRS-277 (second edition), and TRS-398 (in press), the latter being the new protocol in terms of absorbed dose to water that will gradually replace the air kerma based TRS-277. Electronic spreadsheets were developed for all of them.
- Published multiple Agency TECDOCs and internal reports on dosimetry and radiotherapy quality assurance, notably TECDOC-1040 in collaboration with other Agency Sections.
- Increased notably the number of publications in peer reviewed journals and participation in scientific conferences, in support of the dissemination of the Agency's activities in the field. Details are available in the DMRP Internet pages.
- Developed a computerized database of radiotherapy centres (DIRAC), as a joint effort with WHO. DIRAC includes data on teletherapy machines, on sources and devices used in brachytherapy, and on equipment for dosimetry, patient dose calculation and quality assurance. Staff strength at the installations (radiation oncologists, medical physicists, technicians, etc.) is also included. The database is available in the form of a CD-ROM.
- Increased substantially the number of Agency Technical Co-operation projects receiving technical support from the Section.
- Established harmonized programmes and a syllabus for the education of medical physicists, notably supporting the establishment of a regional MSc programme in Latin America.
- Developed further our relationship with other international organizations like WHO, PAHO, ICRU and IOMP. Participation in the International Advisory Council of the IOMP deserves special mention.
- Developed Internet pages for the dissemination of information on the activities and publications of the DMRP Section.

These achievements would not have been possible without the work of a team of greatly motivated and well prepared professionals, laboratory technicians and efficient administrative staff.

Last, but not least, I am grateful to the SSDL Scientific Committee throughout these years, whose encouraging support and advice has contributed so much to the success of the implementation of the Agency's DMRP Sub-Programme.

I wish all the SSDL Network Members a successful future.

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[a] This is the general e-mail address of the DMRP Section where all correspondence not related to specific tasks of the staff above should be addressed. Please note also that there is a considerable circulation of the staff of the Agency, so that messages addressed to someone who has left might be lost. All incoming messages to this mailbox are internally distributed to the appropriate staff members.

SERVICES PROVIDED BY THE IAEA PROGRAMME IN DOSIMETRY AND MEDICAL RADIATION PHYSICS

The IAEA's Dosimetry and Medical Radiation Physics programme is focused on services provided to Member States through the IAEA/WHO SSDL Network and dose quality audits. The measurement standards of Member States are calibrated, free of charge, at the IAEA's dosimetry laboratory. The audits are performed through the IAEA/WHO TLD postal dose assurance service for SSDLs and radiotherapy centres, and the International Dose Assurance Service (IDAS) for SSDLs and radiation processing facilities, mainly for food-irradiation and sterilisation of medical products.

The range of services is listed below.

Services	**Radiation quality**
1. Calibration of ionization chambers (radiotherapy, diagnostic radiology including mammography, and radiation protection, including environmental dose level).	X-rays (10-300kV) and gamma rays from ^{137}Cs and ^{60}Co
2. Calibration of well-type ionization chambers for brachytherapy Low Dose Rate (LDR).	γ rays from ^{137}Cs
3. Intercomparison of therapy level ionization chamber calibrations (for SSDLs).	γ rays from ^{60}Co
4. TLD dose quality audits for external radiotherapy beams for SSDLs and hospitals.	γ rays from ^{60}Co and high energy X-ray beams.
5. TLD dose quality audits for radiation protection for SSDLs.	γ rays from ^{137}Cs
6. ESR-alanine dose quality audits for radiation processing (for SSDLs and industrial facilities), through International Dose Assurance Service (IDAS).	γ rays from ^{60}Co, dose range: 0.1-100 kGy
7. Reference irradiations to dosimeters for radiation protection (for IAEA internal use).	X-rays (40-300 kV) and γ rays from ^{137}Cs and ^{60}Co

Member States who are interested in these services should contact the IAEA/WHO Network Secretariat for further details, at the address provided below. Additional information is also available through the Internet at the web site: http://www.iaea.org/programmes/nahunet/e3/

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SCIENTIFIC COMMITTEE OF THE IAEA/WHO NETWORK OF SECONDARY STANDARD DOSIMETRY LABORATORIES

Report of the Ninth Meeting of the SSDL Scientific Committee
IAEA, Vienna, 13-17 November 2000

Participants

Committee members:

A. Allisy, ICRU, Chairman of the SSC
P.J. Allisy-Roberts, BIPM
A. Dutreix (France)
J.R. Böhm, PTB (Germany)
S.M. Seltzer, NIST (USA)
P.H.G. Sharpe, NPL (UK)
S. Shen (China)

WHO:

H. Østensen, WHO,
Co-Secretary of the IAEA/WHO SSDL network

Observers:

W.F. Hanson, RPC (USA)
A. Leitner, BEV (Austria)

IAEA staff members:

A. Meghzifene, Acting Head, Dosimetry and Medical Radiation Physics Section, NAHU, Co-Secretary of the IAEA/WHO SSDL network

J. Izewska, Dosimetry and Medical Radiation Physics Section

F. Pernicka, Dosimetry and Medical Radiation Physics Section

S. Vatnitsky, Dosimetry and Medical Radiation Physics Section

H. Toelli, Dosimetry and Medical Radiation Physics Section

R. Girzikowsky, Dosimetry and Medical Radiation Physics Section

P. Bera, Dosimetry Laboratory, NAAL

L. Czap, Dosimetry and Medical Radiation Physics Section

FOREWORD

The report of the eighth meeting (held in Oct. 1998) of the Scientific Committee (SSC) of the IAEA/WHO network of Secondary Standard Dosimetry Laboratories (SSDL) was published in the SSDL Newsletter No. 40, January 1999.

The ninth meeting was held in Vienna at the Agency Headquarters from 13 to 17 November 2000. Opening remarks were made by Mr. S. Groth, Director, Division of Human Health (NAHU), Mr. H. Østensen (WHO), Co-Secretary of the IAEA/WHO SSDL network, and Mr. Ahmed Meghzifene, acting Section Head, Dosimetry and Medical Radiation Physics (DMRP).

Mr. Groth informed the Committee that the SSC was the only Standing Committee overlooking activities in the Division of Human Health, and that he felt it has been instrumental in keeping the sub-programme focussed. He emphasized that medicine is one of the most important applications of the nuclear field, with 2.5 million people working in medical applications of nuclear energy. This is 3 times as many people as those who work in either nuclear power or industrial applications and 10 times as many as those who work in agricultural applications. He suggested that the TLD network, which is well known and appreciated world wide, is one of the most important functions of the DMRP section, operated in conjunction with the WHO. He credited the SSC with major contributions to these efforts. He emphasized that it was important that the Agency should not duplicate what other agencies, nations or entities could provide, but should serve its unique role.

Mr. Østensen discussed the fact that the WHO is undergoing continuing restructuring, which is aimed at making the Organization more efficient and cost-effective. He remains the only person assigned to oversee radiation medicine and diagnosis. He expressed his personal gratitude to the Agency for their efforts in collaboration with the WHO. He noted that it was very important that the WHO have some involvement in the Agency's sub-programmes in dosimetry and medical radiation physics, although he was unable to obtain resources for such work. He felt that the joint effort created some important symbiosis between the WHO and the Agency. He emphasized that the highest priority from the viewpoint of the WHO is improving the availability and quality of diagnostic imaging, where there is a tremendous need throughout the developing world. He was pleased to see the

project to develop the Code of Practice (CoP) for diagnostic radiology and was very eager to participate in this and the other projects of the Agency. However, because of limited resources, his contribution must be limited primarily to hand, mind, and moral support.

Mr. Meghzifene spoke of Mr. Pedro Andreo who resigned from his position of Section Head, DMRP, and is now back in Sweden. Mr. Andreo apologized for not being able to attend this meeting. Due recognition should however be paid to his efforts to finalize the DMRP Section report for the SSC meeting before his departure.

Mr. Allisy, Chairman of the SSDL Scientific Committee then thanked Mr. Groth for the efforts that the Agency had made to respond favourably to the recommendations of the Committee. He emphasized the important role the Agency provided to develop links between developing countries and the international metrology community. He also emphasized the importance of the policy of the DMRP Section to avoid giving the impression of a regulator, but rather to provide encouragement to the Member States to improve their metrology and provide technologies to accomplish these improvements. Mr. Allisy also took the opportunity to express his sadness over the passing away of Mr. Kálmán Zsdánszky, who had served the Agency and the DMRP so faithfully and competently for very many years, and to recognize his many contributions.

Mr. Meghzifene then introduced the DMRP staff members who presented reports during the first two days of the meeting on their various activities. The SSC then met in closed session with him until Friday noon, deliberating the accomplishments and direction of the Agency's sub-programme, and developing specific recommendations. The list of participants in the meeting and the meeting agenda are enclosed as Appendices I and II, respectively.

The SSC regretted the absence of Mr. Andreo, the outgoing DMRP Section Head, at the committee meeting but wished to thank him for providing a comprehensive overview of the activities of the Section for 1999-2000 together with a projection for 2001-2003. His report gave the SSC a clear overall picture prior to the meeting and served as a written reference for discussions during the meeting. The SSC commended the present DMRP staff for their level of accomplishments over the past few years, for presenting their accomplishments and proposed activities in a clear and concise manner, and for providing straightforward responses to questions from the SSC.

The SSC evaluated the activities of the DMRP reported for 1999-2000 and discussed the proposed sub-programme for the Section for 2001 and 2002-2003. The scope of the SSC evaluation addressed the questions of:

- The objective of the sub-programme areas
- The impact (benefit to the Member States)
- The continuing relevance of Agency activities

Specific recommendations from the SSC are underlined throughout the text, but are also reiterated at the end of the report.

1. INTRODUCTION

The DMRP report and the presentations from the staff clearly showed the SSC that the DMRP had responded to all recommendations of the previous SSC report (SSDL Newsletter #40, January 1998), and implemented most of the recommendations. In general, the activities of the DMRP support the aims of the Agency's Dosimetry and Medical Radiation Physics sub-programme.

The DMRP Section's activities are performed under four identifiable projects:

- PROJECT E.3.01: Secondary Standards Dosimetry Laboratory (SSDL) network.
- PROJECT E.3.02: Dose Intercomparison and Assurance
- PROJECT E.3.03: Transfer of Dosimetry Techniques
- PROJECT E.3.04: Technical Co-operation Activities

Beginning with the biennium 2002-2003, the projects are changed to:

- PROJECT E.3.01: network of Secondary Standard Dosimetry Laboratories (SSDLs)
- RROJECT E.3.02: Quality Assurance and Dose Audits to End-Users
- PROJECT E.3.03: Research and Development in Radiation Dosimetry Techniques
- PROJECT E.3.04: Developments in Radiotherapy Physics Quality Assurance.

In the new format, E.3.01 and E.3.02 only address the provision of services to Member States and all CRPs (research and development) have been moved to E.3.03 and E.3.04. Projects E.3.03 and E.3.04 separate the activities in the current Project

E.3.03 ("Transfer of dosimetry techniques"); with the new E.3.04 focussing only on projects in the field of Radiotherapy Physics Quality Assurance. Technical Co-operation activities, previously performed under E.3.04 will be merged under the relevant new Project titles. However, this SSC report is organized following the Project numbers used during the reporting period (prior to 2002).

This report begins with a general discussion of administrative items and collaborative efforts within the Agency. Each project is then discussed in turn. The report summarizes only those activities of the Section for which the SSC has comments or recommendations. Exclusion of specific activities should be interpreted positively, as concurrence by the SSC with the activity as reported.

2. REPORT

2.1 General Organizational Items

2.1.1 Membership of the SSC

The SSC recommends increasing its membership by one to include an additional member from an SSDL that has experience with an external audit group (EAG) or network.

2.1.2 Timing for the SSC meeting

Bearing in mind the timing of the Agency programme development, it is recommended that the SSC meets early enough in the programme formulation process so that its recommendations can be considered before the programme is presented to the Member States.

2.1.3 Mutual Recognition Arrangement (MRA)

The SSC is pleased that the Agency has signed the Mutual Recognition Arrangement (MRA) as this consolidates the link between the IAEA, the SSDL network and the international measurement system. The SSC recommends that the DMRP continue to participate in comparisons of regional metrology organizations (RMOs), e.g. EUROMET and SIM, to demonstrate its calibration and measurement capabilities (CMC). It is further recommended that the DMRP pursue publication of an invited article in the SSDL Newsletter regarding the MRA and its impact on the SSDL network.

2.1.4 Regional Metrology Organization (RMO)

The SSC recommends that the DMRP, together with the BIPM, consider the possible role of the Agency in operating as an RMO in ionizing radiation dosimetry for Member States not otherwise participating in an RMO. The Agency needs to recognize that additional resources would need to be provided to support such a new role.

2.1.5 The Agency's Dosimetry Laboratory

The many activities of the Agency's Dosimetry Laboratory require measurements of high accuracy and the programmes have a significant influence on radiation metrology world-wide as well as an impact on doses received by individual patients or irradiated products.

The Dosimetry Laboratory is integrated into the IAEA's Laboratories (Seibersdorf). The range of services provided to the SSDL network include:

- Calibration of ionization chambers for radiotherapy, diagnostic X-rays including mammography, and radiation protection.
- Calibration of re-entrant ionization chambers for low dose rate brachytherapy sources (^{137}Cs).
- TLD dose quality audits for external radiotherapy beams (for SSDLs and for hospitals)
- ESR-alanine dose quality audits for radiation processing (for SSDLs and for facilities)
- TLD dose quality audits for SSDLs providing dosimetry for personnel monitoring.

Cobalt-60 gamma radiation is essential for radiotherapy calibrations. The Agency's present cobalt unit is now 25 years old, and it is becoming increasingly difficult to maintain the metrological quality needed in the Agency's measurement programme for radiotherapy. Commercially available replacement units cannot be located in the present bunker, as it is too narrow to accommodate the loading of the source and proper maintenance of the unit. Consequently, the SSC recommends that a project to build a new bunker to house a second cobalt unit be started now, to ensure that the new facility is operational in 4 or 5 years.

The SSC further recommends that, with the additional bunker and unit, the existing bunker and ^{60}Co unit be maintained and used for the increasing number of radiation protection calibrations, and for the training of Fellows. This arrangement will provide the space necessary to relieve the current overcrowding and avoid compromising the accuracy required for radiotherapy calibrations.

In the report of SSC-8, it was recommended that the responsibilities and duties of NAHU and NAAL be clearly defined and documented. The SSC is pleased that this recommendation was approved by the DG. To ensure that the quality system of the DMRP metrological activities meets the requirement of the mutual recognition arrangement (MRA) signed by the Agency, this recommendation now needs to be implemented by the two divisions concerned.

2.1.6 The high-dose dosimetry task

The Agency's laboratory provides dosimetry quality assurance services for high-dose irradiation facilities in support of programmes sponsored by other Divisions in the Agency (specifically the Division for Food and Agriculture (NAFA) and the Division of Physics and Chemistry (NAPC)). The SSC regrets that the support requested of the NAFA and NAPC for the high-dose dosimetry service (IDAS) has not been forthcoming. This lack of support is surprising in view of the requirement for dose assurance, including measurement traceability, both for food irradiation and sterilization of medical devices. However, given the resultant low financial priority, the SSC recommends that the DMRP prepare contingency plans for the 50 non-commercial users (from 46 developing countries) of IDAS in the event that the service be suspended because of severe equipment failure.

2.1.7 Patient protection issues

The SSC commends the collaboration among NAHU, NSRW, the PAHO and the WHO in organizing the international conference (Malaga, Spain, 26-30 March 2001) on all aspects of protection of the patient concerning diagnostic and therapeutic uses of ionizing radiation.

The SSC recognizes that there are many aspects of patient protection, including clinical, regulatory, physical and technical components. These latter two aspects, including dosimetry, equipment and measurement quality assurance, clearly lie within the expertise of DMRP/NAHU. Consequently the SSC recommends that the DMRP be directly involved in any Agency activities relating to the radiation protection of the patient that include physical and technical components.

2.1.8 Collaboration with the World Health Organization (WHO)

With continued support from the WHO and particularly Mr. Østensen, the turn-around time and level of participation in the IAEA/WHO postal TLD service continues to improve. The SSC commends the WHO in their dedication to improving the performance of the postal TLD service. The SSC recognizes that the contribution from the WHO is essential to the success of this service and trusts that the World Health Organization will continue, and increase, its support.

The SSC recommends that training programmes in radiation dosimetry and medical physics applications, proposed by the Agency, the PAHO or the WHO, be planned and carried out in collaboration with each other, where there are common interests. This is particularly important because the PAHO and the WHO have direct contacts with the health authorities in the Member States.

The SSC further recommends that joint IAEA/WHO seminars be organized for regional officers concerned with human health. These seminars should explain:

- the importance of coherent dosimetry linked to the international measurement system,
- the role of staff training in dosimetry techniques,
- the promotion of the IAEA/WHO hospital audit service in radiotherapy dosimetry, and
- the importance of the SSDL network in providing the necessary measurement assurance.

2.2 Project E.3.01 Secondary Standard Dosimetry Laboratory (SSDL) Network

The IAEA/WHO SSDL network presently consists of 73 laboratories in 61 Member States (more than half are developing countries) and 20 affiliated members [international organizations and Primary Standard Dosimetry Laboratories (PSDLs)]. The SSC welcomes the new members in Viet Nam, Ethiopia, Greece and Germany and the two new affiliate members in the Slovak Republic and Spain. There are current technical co-operation projects related to the establishment of new SSDLs in Jordan, Lebanon, Latvia (to also serve Lithuania and Estonia) and Georgia.

Membership in the network is open to laboratories designated by their national competent authority. The privileges, rights and duties of members in the network are laid down in the SSDL Network Charter, published by the IAEA in 1999.

Active SSDLs provide traceable instrument calibrations for radiation therapy, diagnostic

radiology including mammography, brachytherapy (137Cs), occasionally provide quality audits of radiotherapy by postal TLD and on-site measurements, and some perform measurements at radiation processing levels. The implementation of such a programme requires that the traceability of the SSDLs to a PSDL or to the Agency be verified periodically through quality audits and intercomparisons organized by the DMRP. It was noted that almost all SSDLs (97%) provide radiation protection level calibrations, many without traceability through the Agency.

Since 1991, the DMRP has focused efforts on follow up of the results of all of the audit services when an SSDL (or hospital) fails the audit with a disagreement with the Agency exceeding appropriate action levels. This follow-up programme has been very successful

2.2.1 Membership issues

The SSDL Network Charter established a category of 'provisional member' for SSDLs who do not fulfil the obligations of full membership. This category is considered to be temporary while efforts are made by the provisional member to comply with the Charter. There are presently 4 laboratory members considered as provisional members, Nigeria, Sudan and the two SSDLs in Iraq. The SSC commends the DMRP for identifying, as provisional members, SSDLs that do not comply with the SSDL Network Charter. The SSC recommends that if an SSDL is listed as a provisional member for 3 years, the Agency should write to the Member State suggesting that the status be reviewed and an alternative laboratory considered for designation as the SSDL, if appropriate.

The main objective of the SSDL network is to ensure traceability of measurements, for those Member States that do not have access to primary standard dosimetry laboratories, by providing and maintaining the link between the end users of radiation and the international measurement system. The SSC, aware of the limited resources of the DMRP, strongly urges the Agency to give priority for services to those developing countries that do not have a primary standards laboratory.

In the light of new memberships to the SSDL network, the SSC recommends that the Agency review the guidelines to Member States on the designation of an SSDL in the IAEA/WHO network. The review should take into account the main objective of the network, i.e. to ensure traceability of measurements for those States that do not have access to primary standard dosimetry laboratories.

The SSC recommends that the Agency invite Member States to review the status of membership of their laboratories in the SSDL network, with a view to reclassifying the SSDL as an affiliate member in cases where it has developed a primary dosimetry standard linked to the international measurement system.

2.2.2 Intercomparison of therapy level ionization chamber calibration factors

In this proficiency test programme, the SSDL verifies its ability to transfer a calibration from their standard to the user. The SSDL calibrates an ionization chamber of its choice, and forwards it to the DMRP Section for their calibration. Twenty SSDLs participated in this ion chamber intercomparison during 1999-2000, 17 reports are complete and three are pending. The results are presented in Figure 1. Calibrations both in terms of air kerma and absorbed dose to water are included. The two discrepancies exceeding the DMRP action level (±1.5%) were pursued. One was resolved and one is pending.

The SSC commends the DMRP for having purchased additional chambers to serve as working dosimetry standards and so to avoid using reference standards in this capacity. The SSC recommends that, once the programme of measurements to confirm the stability of the new chambers has been completed successfully, they be designated as the new working standards in the laboratory procedures (DOLP) and the reference standards no longer be used as working standards.

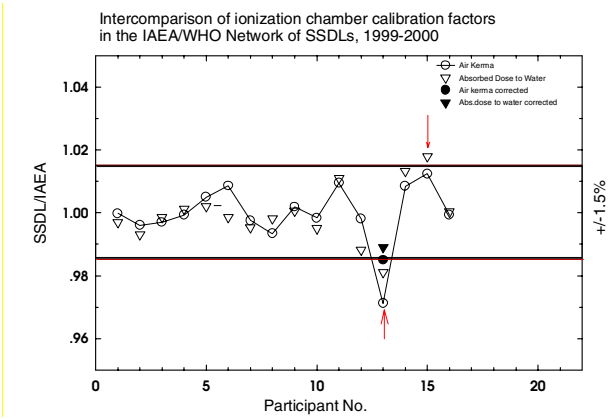

FIGURE 1. Results of the ion chamber intercomparisons. Data points are the ratios of ion chamber calibration factors supplied by the SSDLs to those measured by the IAEA. Circles correspond to air kerma calibration factors and triangles to absorbed dose to water factors. The solid symbols indicate the results of repeat intercomparisons.

2.2.3 *TLD monitoring of SSDL measurements at therapy levels*

This measurement assurance programme is to verify the ability of the SSDL to transfer the ionization chamber calibration to the determination of absorbed dose under reference conditions in a water phantom. The SSDL irradiates TLDs at a reference depth in a cobalt-60 or high-energy X-ray beam. The TLDs are evaluated at the Agency's Dosimetry Laboratory. Sixty-three SSDLs participated in this TLD service in 1999-2000, irradiating TLD in 164 beams of ^{60}Co and high-energy X-rays. The results are seen in Figure 2. Seven (4%) of the TLD results were outside the Agency's 3.5% action level, and were followed-up by the DMRP. All but one of the discrepancies have been resolved.

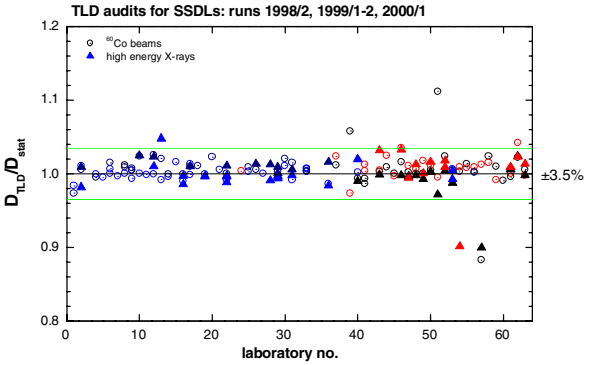

FIGURE 2. Results of the IAEA/WHO postal TLD dose audits of SSDLs for the delivery of dose to water under reference conditions. Data correspond to the ratio of the Agency's determined dose from the TL-response (D_{TLD}) to that stated by the SSDL (D_{stat}). Each data point corresponds to the average of three dosimeters.

2.2.4 *Calibration of ionization chambers at diagnostic X-ray energies, including mammography*

The survey conducted following the recommendation of SSC-8 indicates that 40% of the SSDLs calibrate instruments for diagnostic radiology, including 13% of the SSDLs who calibrate at mammographic X-ray beam qualities. The survey indicates a lack of standardization in equipment and radiation beam qualities.

The DMRP has been developing facilities and procedures for the calibration of ionization chambers at mammography beam qualities. They have developed 17 beam qualities with HVL from 0.27 mm Al to 0.85 mm Al. These represent both Mo and Rh target and absorbers for both entrance and exit dose qualities. They also obtained calibration of their laboratory standard and initiated a calibration service for the SSDLs. Three mammography chambers have been calibrated (27 calibration points) and 5 chambers are scheduled in the near future.

The SSC commends the DMRP for having established the calibration service at mammographic X-ray beam qualities. The SSC recommends that the DMRP conduct a pilot study to determine the appropriate external audit technique to assure measurement quality at the SSDLs for these beam qualities.

The DMRP has also begun expanding their activities in conventional diagnostic radiology. The activities include a CRP to develop a Code of Practice for diagnostic radiology and the characterization of various X-ray beam qualities for their tungsten target X-ray generator with energies from 50 kVp to150 kVp. The SSC is pleased that a co-ordinated research project (CRP) has been organized to develop this Code of Practice for diagnostic radiology, both for chamber calibrations and the use of these chambers in hospitals. The SSC recommends that a laboratory programme be initiated for the establishment of the IEC diagnostic X-ray beam qualities at the DMRP. The SSC further recommends that the subsequent calibration service be carried out at least at three representative beam qualities.

2.2.5 *Activities in brachytherapy dosimetry standards*

The Agency has two ^{137}Cs low dose rate brachytherapy sources calibrated at the National Institute of Standards and Technology (NIST) USA, and a well ionization chamber as a transfer instrument. In the reporting period, SSDLs only submitted two well ionization chambers for calibration. From the survey recommended by SSC-8, up to 50% of SSDLs indicate current or planned capabilities to calibrate brachytherapy sources. The SSC recommends that the DMRP provide the SSDLs with the information from DIRAC on the users of HDR brachytherapy in their country, and conduct a survey to determine how many SSDLs would use calibration and subsequent measurement quality assurance services from the Agency, specifically for HDR ^{192}Ir brachytherapy. If a significant number of SSDLs in developing countries indicate a need for these services, the SSC recommends that the DMRP undertake a pilot study to determine the best way to meet these needs.

2.2.6 TLD dose quality audits for radiation protection

A regular TLD dose audit service for ^{137}Cs radiation protection calibrations was established for Member States in 1999. The SSDLs and selected PSDLs are asked to irradiate TLDs in a ^{137}Cs beam to a specified air kerma. The TLDs are then evaluated by the Agency. The results of three TLD runs are presented in Figure 3 showing that about 30% of the SSDLs are outside an acceptance limit of ± 3.5%. These SSDLs are contacted and support is provided to resolve the discrepancies. As a routine, they are invited for the next run. The SSDL's performance during the follow-up exercises is also shown in the Figure 3. Follow-up continues.

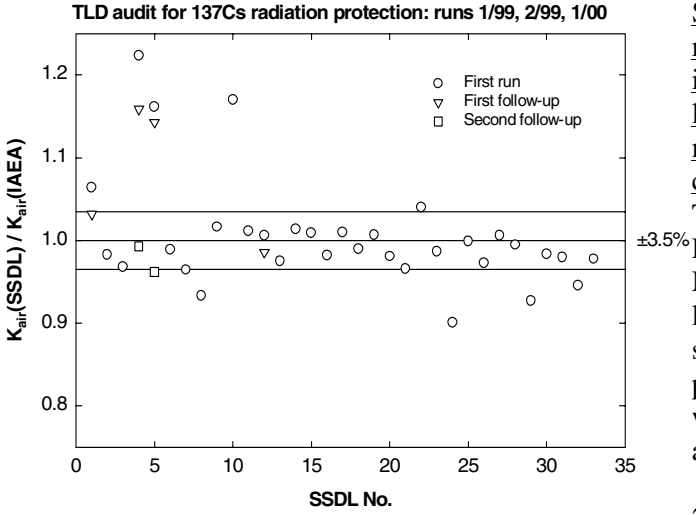

FIGURE 3. Ratios of the air kerma stated by SSDLs to the TLD measured value at the IAEA dosimetry laboratory.

2.2.7 Operational Quantities for radiation protection

The SSC commends the DMRP for maintaining standards for ambient dose equivalent and recommends that the Agency encourage the use of this quantity by the SSDLs for calibrations for radiation protection. The SSC notes that chambers designed for calibration in operational quantities are becoming more readily available. Consequently, the SSC recommends that the DMRP undertake a survey to determine the SSDL's secondary standard instrument, the SSDL traceability, the types of instruments calibrated, and the radiation protection dosimetric quantities disseminated. The results of this survey should be used to determine the programme of action for the DMRP that will help to implement the international Basic Safety Standard.

The SSC further recommends that the DMRP extend its capabilities to include standards for and dissemination of calibration in terms of personal dose equivalent [$H_p(10)$] using the ISO water slab phantom, for those SSDLs involved in personal dosimetry.

2.2.8 Measurement Quality Assurance (MQA) in nuclear medicine

From the summary of annual reports from the SSDLs, the majority of those indicating that they undertake activity measurements are from developing countries. The SSC welcomes the decision of NAHU to extend the DMRP expertise to include a medical physics professional staff member in nuclear medicine in the programme cycle 2002-2003.

The SSC recommends that the DMRP contact all SSDLs to indicate the new initiative into nuclear medicine metrology and quality assurance, and identify whether the SSDL itself or another laboratory is responsible for activity measurements for nuclear medicine in their country and which radionuclides are measured. This information should be used to define the DMRP activities in this field to meet the needs of Member States and to help identify the additional laboratory space and equipment required to support these activities. The SSC would be pleased to assist in the definition of the activities, which it believes should focus on measurement aspects.

2.3 Project E.3.02 Dose Intercomparison and Assurance

2.3.1 The IAEA/WHO TLD postal service for hospitals

The IAEA/WHO TLD postal programme for monitoring the calibration of radiation therapy beams at hospitals in Member States continues. The SSC applauds the DMRP and the WHO on a number of changes aimed at improving the efficiency and efficacy of the service.

2.3.1.1 Automatic reader system

The Agency has implemented an automatic TLD reader, so that up to 500 beams evaluations can be performed per year.

2.3.1.2 Turn-around time

The DMRP has been able to reduce the total turn-around time for the postal TLD to under 3 months, partly through in-house improvements but principally through efforts in dissemination of the postal packs as co-ordinated by the WHO and the PAHO. The SSC is pleased

to see these improvements continue, and recognizes the important contributions from the WHO and the PAHO.

2.3.1.3 Improved return rate

The return rate for the TLD has also increased dramatically from between 50% to 60% in the early 1990s to 95% in this reporting period (1998-2000). This dramatic increase is due to the joint efforts of the WHO and the DMRP. The SSC continues to be pleased with these results.

2.3.1.4 Follow-up of hospitals outside the acceptable limits

TLD verification of 660 beams at 382 radiotherapy centres was accomplished in the reporting period. The results are shown in Figure 4. In 1999-2000, 183 additional radiotherapy centres joined the TLD network, representing 256 of the 660 beams. As is shown, 84% are within the ± 5% action level and 16% are outside the action level. The DMRP has established a follow-up programme for hospitals outside acceptable limits, consisting of three levels:

- contacting the hospital either through the WHO or the PAHO, or directly by DMRP staff;
- involving the local SSDL in the resolution of the discrepancy, and
- involvement of an expert.

The results of this follow-up are seen in Figure 5. These data pertain to the 73 radiotherapy facilities where a discrepancy was discovered. As can be seen, approximately 50% of the discrepancies were resolved by the centre themselves, while nearly one quarter required assistance from the SSDL or an expert. Nearly 30% are still unresolved.

The SSC encourages the DMRP to produce a document discussing the causes of significant discrepancies discovered during TLD audits and the methods of correcting them, to help all participants of the TLD audit service.

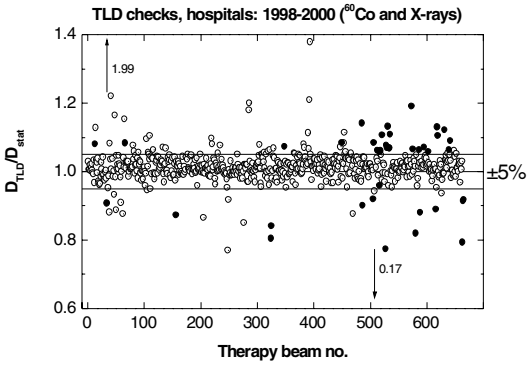

FIGURE 4. Results of the IAEA/WHO TLD postal dose audits of radiotherapy hospitals for the delivery of absorbed dose to water under reference conditions during 1999-2000. Data in the graph correspond to ratios of the Agency's determined dose (D_{TLD}) relative to the dose stated by the hospital (D_{stat}). Each data point corresponds to the average of two dosimeters. A total of 660 beam calibrations were checked in 381 radiotherapy facilities. Approximately 16% of the results were found outside the ±5% action level. Black dots indicate the deviations that have not been corrected (before September 2000).

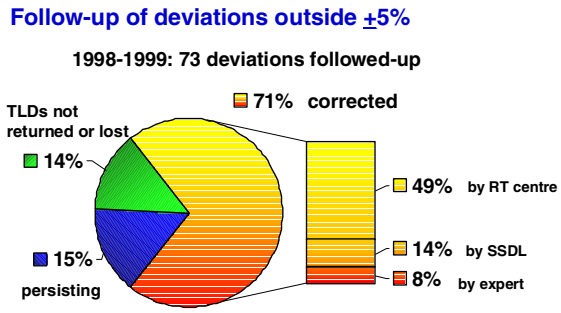

FIGURE 5. Pie chart showing the outcome of follow-up dosimeters sent to hospitals outside the action level. Seventy one percent are resolved.

2.3.1.5 Benefits of repeat TLD

The benefit of the external audit is seen in that only 79% of the radiotherapy facilities using the Agency TLD service for the first time were within the 5% action level, while 88% of radiotherapy facilities that have benefited from a previous TLD audit were inside the action level.

The committee is delighted with the actions of the DMRP in improving the turn-round time, percentage of returns, follow up of discrepancies and measurement quality of the IAEA/WHO TLD audit service. It recommends that the maximum capacity of this service (500 beams check per year) continue to be directed towards the developing countries that do not yet have their own External Audit Group (EAG).

2.3.1.6 *Transfer of TLD programmes to Member States*

There are seven Member States (China, India, Argentina, Algeria, Czech Republic, Israel, and Malaysia) that have established External Audit Groups (EAGs) utilizing TLD and usually on-site reviews to audit hospitals in their countries, and which have a formal link to the DMRP laboratory. Recently five other Member States started the process of establishing such programmes (Columbia, Cuba, Philippines, Poland, and Viet Nam). An additional 10 Member States have made preliminary inquiries about establishing such programmes. All EAGs participate with the DMRP in reference TLD irradiations and blind TLD tests to end-users.

The SSC strongly supports the project (extension of CRP E2.40.07) to establish national QA programmes for radiation therapy dosimetry in developing countries. This CRP will finish at the end of 2000, and the SSC urges the IAEA to publish the guidelines as soon as possible. This will encourage the 12 EAGs to follow the guidelines. The SSC recommends that the Technical Co-operation Department be prepared to support the requests from at least another 10 developing countries to establish such EAGs and to implement these guidelines. As it is the responsibility of the DMRP to ensure the quality of measurements performed by the EAGs, including coherence with the international measurement system, the SSC recommends that the programme of external audits (reference irradiations and blind tests) of the EAGs be continued.

2.3.2 High dose dosimetry

The DMRP continues to provide the International Dose Assurance Service (IDAS) at radiation processing dose levels using alanine dosimeters issued and evaluated at the Agency's Dosimetry Laboratory. In 1999-2000, the IDAS audit service provided 141 beam calibration audits at 75 facilities, many new to the IDAS. Two thirds of the facilities are non-commercial research institutes and ¾ are in developing countries. The results are shown in Figure 6. Sixty three percent are within the ± 5% action level. Follow-up of those outside the action level includes repeat dosimeters and assistance by letter. Repeat dosimeters were sent to 24 institutions. Of these, 10 are now within the ± 5% action level, 2 were outside, and 12 are still pending.

The SSC recognizes that this is a dosimetry programme with a high level of accuracy that must be recognized for the value of its services. However, the Agency programmes that benefit most from these services are not within the DMRP. This dosimetry programme therefore consumes more than its fair share of resources in the DMRP. See section 3.1.6 for further discussion.

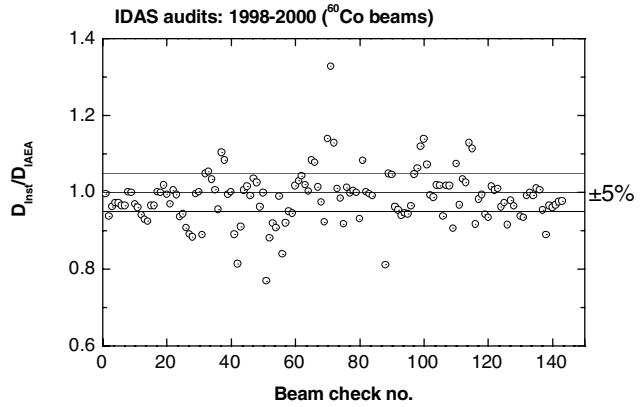

FIGURE 6. Results of the IAEA IDAS postal dose audits of radiation processing facilities for the delivery of absorbed dose to water under standard conditions during 1998-2000 (before September 2000). Data in the graph correspond to ratios of the dose stated by the institution (D_{inst}) relative to the Agency's determined dose (D_{IAEA}). Each data point corresponds to the average of three dosimeters. A total of 141 beam calibrations were checked.

2.4 Project E.3.03: Transfer of Dosimetry Techniques

The transfer of dosimetry techniques in the DMRP sub-programme is provided through Co-ordinated Research Projects (CRPs), training courses, fellowships, seminars, symposia, and publications. Computer databases are also included in this project. Technical Co-operation (TC) projects, which are an important mechanism to transfer technology to developing countries, are covered under Project E.3.04.

2.4.1 Computer databases

The DMRP is responsible for maintaining 3 IAEA computerized databases.

- IAEA/WHO SSDL network, for internal use only.
- IAEA/WHO TLD postal service (IDEA), for internal use only.
- Directory of Radiotherapy Centres (DIRAC), in collaboration with the WHO, for internal and external use.

The SSC welcomes the work of the DMRP to update the Directory of Radiotherapy Centres (DIRAC) and its production in draft electronic

form. Recognizing that the data in the database is incomplete and the need for quality assurance, the SSC encourages the DMRP to continue validating and updating the data, and looks forward to publication of the interactive version on the World Wide Web.

2.4.2 Internet access to DMRP web pages

Eight Web pages for DMRP are available on the Internet. These appear very popular, with nearly 20,000 hits and the downloading of more than 700 documents in the first 9 months of 2000.

2.4.3 Co-ordinated Research Projects (CRPs)

The list of active CRPs is included in Table 1, and the list of proposed CRPs is given in Table 2. The SSC supports the submission of the CRP on non-reference dosimetry audits as being timely.

TABLE 1. CO-ORDINATED RESEARCH PROJECTS (CRPS) ACTIVE DURING THE REVIEW PERIOD.

Year of start	Subject	Year of comp-letion	Partici-pating Institu-tions
1995	E2 40 06 Characterization and evaluation of high-dose dosimetry for quality assurance in radiation processing: TecDoc-1156 published in 2000.	1999	10
1996	E2 10 02 Development of a quality assurance programme for Secondary Standard Dosimetry Laboratories. Final report completed	1999	5
1995	E2 40 07 Development of a quality assurance programme for radiation therapy dosimetry in developing countries. CRP extended and additional members added.	2000	13
1996	E2 40 08 Dose determination with plane-parallel ionization chambers in therapeutic electron and photon beams. TecDoc 1173 published 2000.	1999	6
1997	E2 40 09 Development of a Code of Practice for dose determination in photon, electron, and proton beams based on measurements standards of absorbed dose to water. TRS-398 prepared and submitted for publication (in press). Extension of CRP approved for testing and implementation of the CoP.	2000 (2002)	7
2000	E2 10 03 Dosimetry in X-ray diagnostic radiology: An International Code of Practice	2003	5
1997	E2 40 10 Alanine-ESR dosimetry for radiotherapy Cancelled (1999) due to lack of funding.		
1998	E2 40 11 EPR bio-dosimetry (jointly with NSRW) Implementation postponed due to delay in recruitment of the new staff member. Last Research Co-ordination Meeting to be held in 2001.	2001	9

TABLE 2. CO-ORDINATED RESEARCH PROJECTS PLANNED/PROPOSED (NOT YET APPROVED) FOR 2001 AND 2002-2003.

Year of start	Subject	Year of comple-tion	Partici-pating Institu-tions
2001	E3.01 (Extension of E2 40 09) Development of techniques for the dissemination of absorbed dose to water standards to the SSDLs.	2003	5-7
2001	E3.02 Development of TLD-based quality audits for radiotherapy dosimetry in non-reference conditions.	2005	5-7
2003	E3.04 Develop procedures for 'in-vivo' dosimetry of cancer patients undergoing radiotherapy treatments.	2006	5-7
2000	E304 Transport simulation for photons/electrons in radiotherapy (in collaboration with NAPC, Nuclear data). Postponed.	2003	

2.4.4 Training courses and symposia

An International Symposium on Standards and Codes Of Practice for Radiation Dosimetry has been approved for the year 2002. The SSC is pleased that an international symposium on standards and codes of practice in radiation dosimetry has been approved and budgeted for the next programme cycle. The SSC recommends that the title of the symposium be changed to International Symposium on Standards and Codes of Practice in Medical Radiation Dosimetry, which more accurately reflects its content. Recognizing that it has been a long time since the last symposium (1993), and that there is continuing progress in dosimetry practice, the SSC recommends that the DMRP consider scheduling a medical radiation dosimetry symposium every 5 years.

2.5 Project E.3.04 Technical Co-operation

Technical Co-operation projects are an important way to transfer technology to developing Member States, and a large fraction of the manpower of the DMRP Section is dedicated to TC tasks. In 1999 (through September) DMRP provided support to 74, and 65 in the year 2000, on-going TC projects, respectively, either as the main section responsible for providing the required technical support or sharing the responsibilities with other sections, mainly Applied Radiation Biology and Radiotherapy. Manpower planned for this programme was 20%, however, the true amount of professional manpower dedicated to TC has reached 40%.

The SSC welcomes the growth in requests from Member States for TC projects in medical radiation applications, and recommends additional professional staff resources be made available to cover the continuing increased demand for DMRP services to TC projects.

3. ACTIVITIES PLANNED FOR 2001 AND 2002-2003

The SSC supports the tasks proposed within the four project areas for 2001 and the 2002-2003 cycle, with the inclusion of the recommendations in this report. However, the SSC suggests that a low priority be given to the proposed activities:

- technical meeting on biological and dosimetry aspects of space radiation
- to coordinate a CRP on transport simulation for photons/electrons in radiotherapy.

4. RECOMMENDATIONS

The recommendations are summarized below, in order of presentation in the report.

i. The SSC recommends increasing its membership by one to include an additional member from an SSDL that has experience with an external audit group (EAG) or network.

ii. Bearing in mind the timing of the Agency programme development, it is recommended that the SSC meets early enough in the programme formulation process so that its recommendations can be considered before the programme is presented to the Member States.

iii. The SSC is pleased that the Agency has signed the Mutual Recognition Arrangement (MRA) as this consolidates the link between the IAEA, the SSDL network, and the international measurement system. The SSC recommends that the DMRP continue to participate in comparisons of regional metrology organizations (RMOs), e.g. EUROMET and SIM, to demonstrate its calibration and measurement capabilities (CMC).

iv. It is further recommended that the DMRP pursue publication of an invited article in the SSDL Newsletter regarding the MRA and its impact on the SSDL network.

v. The SSC recommends that the DMRP, together with the BIPM, consider the possible role of the Agency in operating as an RMO in ionizing radiation dosimetry for Member States not otherwise participating in an RMO. The Agency needs to recognize that additional resources would need to be provided to support such a new role.

vi. The Agency's present cobalt unit is now 25 years old, and the present bunker is too narrow to accommodate the loading of the source and proper maintenance of available new units. Consequently, the SSC recommends that a project to build a new bunker to house a second cobalt unit be started now, to ensure that the new facility is operational in 4 or 5 years.

vii. The SSC further recommends that, with the additional bunker and unit, the existing bunker and ^{60}Co unit be maintained and used for the increasing number of radiation protection calibrations, and for the training of Fellows.

viii. In the report of SSC-8, it was recommended that the responsibilities and duties of NAHU and NAAL be clearly defined and documented. The SSC is pleased that this recommendation was approved by the DG. To ensure that the quality system of the DMRP metrological activities meets the requirement of the mutual recognition arrangement (MRA) signed by the Agency, this recommendation now needs to be implemented by the two divisions concerned.

ix. The SSC regrets that the support requested from NAFA and NAPC for the high-dose dosimetry service (IDAS) has not been forthcoming. Given the resultant low financial priority, the SSC recommends that the DMRP prepare contingency plans for the 50 non-commercial users (from 46 developing countries) of IDAS in the event that the service need be suspended because of severe equipment failure.

x. The SSC recognizes that there are many aspects of patient protection, including clinical, regulatory, physical and technical components. These latter two aspects, including dosimetry,

equipment and measurement quality assurance, clearly lie within the expertise of DMRP/NAHU. Consequently the SSC recommends that the DMRP be directly involved in any Agency activities relating to radiation protection of the patient that include physical and technical components.

xi. The SSC recommends that training programmes in radiation dosimetry and medical physics applications, proposed by the Agency, the PAHO or the WHO, be planned and carried out in collaboration with each other, where there are common interests. This is particularly important because the PAHO and the WHO have direct contacts with the health authorities in the Member States.

xii. The SSC further recommends that joint IAEA/WHO seminars be organized for regional officers concerned with human health. These seminars should explain the following:

- importance of coherent dosimetry linked to the international measurement system;
- role of staff training in dosimetry techniques;
- promotion of the IAEA/WHO hospital audit programme in radiotherapy dosimetry;
- importance of the SSDL network in providing the necessary measurement assurance.

xiii. The SSC commends the DMRP for identifying, as provisional members, SSDLs that do not comply with the SSDL Network Charter. The SSC recommends that if an SSDL is listed as a provisional member for 3 years, the Agency should write to the Member State suggesting that the status be reviewed and an alternative laboratory considered for designation as the SSDL, if appropriate.

xiv. The main objective of the SSDL network is to ensure traceability of measurements, for those States that do not have access to primary standard dosimetry laboratories. The SSC, aware of the limited resources of the DMRP, strongly urges the Agency to give priority for services to those developing countries that do not have a primary standards laboratory.

xv. In the light of new memberships to the SSDL network, the SSC recommends that the Agency review the guidelines to Member States on the designation of an SSDL in the IAEA/WHO network. The review should take into account the main objective of the network, i.e. to ensure traceability of measurements for those States that do not have access to primary standard dosimetry laboratories.

xvi. The SSC recommends that the Agency invite Member States to review the status of membership of their laboratories in the SSDL network, with a view to reclassifying the SSDL as an affiliate member in cases where it has developed a primary dosimetry standard linked to the international measurement system.

xvii. The SSC commends the DMRP for having purchased additional chambers to serve as working dosimetry standards so as to avoid using reference standards in this capacity. The SSC recommends that, once the programme of measurements to confirm the stability of the new chambers has been completed successfully, they be designated as the new working standards in the laboratory procedures (DOLP) and the reference standards no longer be used as working standards.

xviii. The survey conducted following the recommendation of SSC-8 indicates that 40% of the SSDLs calibrate instruments for diagnostic radiology, including 13% of the SSDLs who calibrate at mammography X-ray beam qualities. The SSC commends the DMRP for having established a calibration service at mammography X-ray beam qualities. The SSC recommends that the DMRP conduct a pilot study to determine the appropriate external audit technique to assure measurement quality at the SSDLs for these beam qualities.

xix. The SSC is pleased that a CRP has been organized to develop a Code of Practice for diagnostic radiology, both for chamber calibrations and the use of these chambers in hospitals. The SSC recommends that a laboratory programme be initiated for the establishment of the IEC diagnostic X-ray beam qualities at the DMRP.

xx. The SSC further recommends that the subsequent calibration service be carried out at least at three representative beam qualities.

xxi. The SSC recommends that the DMRP provide the SSDLs with the information from DIRAC on the users of HDR brachytherapy in their country, and conduct a survey to determine how many SSDLs would use calibration and subsequent measurement quality assurance services from the Agency, specifically for HDR ^{192}Ir brachytherapy.

xxii. If a significant number of SSDLs in developing countries indicate a need for these services, the SSC recommends that the DMRP undertake a pilot study to determine the best way to meet these needs.

xxiii. The SSC commends the DMRP for maintaining standards for ambient dose equivalent and recommends that the Agency encourage the use of this quantity by the SSDLs for calibrations for radiation protection. The SSC notes that chambers designed for calibration in operational quantities are becoming more readily available.

xxiv. Consequently, the SSC recommends that the DMRP undertake a survey to determine the SSDL's secondary standard instrument, the SSDL traceability, the types of instruments calibrated, and the radiation protection dosimetric quantities disseminated. The results of this survey should be used to determine the programme of action for the DMRP that will help to implement the international Basic Safety Standards

xxv. The SSC further recommends that the DMRP extend its capabilities to include standards for and dissemination of calibration in terms of personal dose equivalent [Hp(10)] using the ISO water slab phantom, for those SSDLs involved in personal dosimetry.

xxvi. The SSC recommends that the DMRP contact all SSDLs to indicate the new initiative into nuclear medicine metrology and quality assurance, and identify whether the SSDL itself or another laboratory is responsible for activity measurements for nuclear medicine in their country and which radionuclides are measured. This information should be used to define the DMRP sub-programme in this field to meet the needs of Member States and to help identify the additional laboratory space and equipment required to support this programme.

xxvii. The SSC encourages the DMRP to produce a document discussing the causes of significant discrepancies discovered during TLD audits and the methods of correcting them, to help all participants of the TLD audit programmes.

xxviii. The committee is delighted with the actions of the DMRP in improving the turn-round time, percent of returns, follow up of discrepancies and measurement quality of the IAEA/WHO TLD audit service. It recommends that the maximum capacity of this service (500 beams checks per year) continue to be directed towards the developing countries, which do not yet have their own External Audit Group (EAG).

xxix. The SSC strongly supports the project (extension of CRP E2.40.07) to establish national QA programmes for radiation therapy dosimetry in developing countries. The SSC recommends that the Technical Co-operation Department be prepared to support the requests from at least another 10 developing countries to establish such EAGs and to implement these guidelines.

xxx. As it is the responsibility of the DMRP to ensure the quality of measurements performed by the EAGs, including coherence with the international measurement system, the SSC recommends that the programme of external audits (reference irradiations and blind tests) of the EAGs be continued.

xxxi. The SSC welcomes the work of the DMRP to update the Directory of Radiotherapy Centres (DIRAC) and its production in draft electronic form. Recognizing that the data in the database is incomplete and the need for quality assurance, the SSC encourages the DMRP to continue validating and updating the data, and looks forward to publication of the interactive version on the World Wide Web.

xxxii. The SSC supports the submission of the CRP on non-reference dosimetry audits as being timely.

xxxiii. The SSC is pleased that an international symposium on standards and codes of practice in radiation dosimetry has been approved and budgeted for the next programme cycle. The SSC recommends that the title of the symposium be changed to International Symposium on Standards and Codes of Practice in Medical Radiation Dosimetry, which more accurately reflects its content. Recognizing that it has been a long time since the last symposium (1993), and the continuing progress in dosimetry practice, the SSC recommends that the DMRP consider scheduling a medical radiation dosimetry symposium every 5 years.

xxxiv. The SSC welcomes the growth in requests from Member States for TC projects in medical radiation applications, and recommends additional professional staff resources be made available to cover the continuing increased demand for DMRP services to TC projects.

xxxv. The SSC supports the tasks proposed within the four project areas for 2001 and the 2002-2003 cycle, with the inclusion of the recommendations in this report. However, the SSC suggests that a low priority be given to the following proposed activities:

- technical meeting on biological and dosimetry aspects of space radiation
- to coordinate a CRP on transport simulation for photons/electrons in radiotherapy.

5. CONCLUDING COMMENTS

The Agency's DMRP sub-programme provides traceable radiation standards to the majority of developing countries over a wide range of energies and dose levels. External-beam radiation therapy and radiation processing (high dose) have a long history and robust links to international standards. Recently the DMRP has developed projects providing robust links for calibration of mammography X-ray beams, brachytherapy sources, and personnel monitoring programmes at the participating SSDLs.

Efforts by the Agency and the WHO over the past 5 years have made significant improvements in the return rate and turn-around time in the postal TLD programme, effectively increasing the availability of Agency standards. Two other high-priority items promulgated by the DMRP are:

i. follow-up of quality audit measurements which fall outside the established action levels, and

ii. transfer of postal TLD programmes to national programmes and establishing and maintaining links between these programmes and the DMRP.

The SSC still considers both of these as high priority items, commends the DMRP on their efforts, and encourages them to continue to develop activities in these areas.

The SSC wishes to emphasize that radiation dosimetry is a necessary adjunct to many programmes that utilize ionizing radiation at various dose levels. The SSC commends the Agency for their continued support for the programmes sponsored through the Dosimetry and Medical Radiation Physics Section. The SSC also commends the DMRP and the Agency for actions already taken to develop communications and programme sharing between DMRP and other Divisions which can benefit from the expertise of the DMRP staff and the measurement standards maintained by the Section.

The SSC again commends the staff of the Dosimetry and Medical Radiation Physics Section for their achievements and for their clear and comprehensive presentation of the Agency's DMRP present and future sub-programme.

The SSC takes the opportunity to thank Pedro Andreo sincerely for all his efforts in enhancing and promoting the work of the DMRP during his tenure as Section Head.

THE EFFECT OF HUMIDITY ON THE MEASUREMENTS WITH A WELL TYPE CHAMBER

1. INTRODUCTION

Since 1996, the IAEA maintains standards for Low Dose Rate (LDR) brachytherapy dosimetry. Data on the standards are given in Table 1.

TABLE 1. IAEA ^{137}Cs LDR STANDARDS FOR BRACHYTHERAPY DOSIMETRY.

Source	Capsule		Active	K_R
	Length (mm)	Diameter (mm)	Dimensions[1] (mm)	(01-05-96) (μGy/h)
CDCS J5	20	2.65	13.5	190.5
CDC1100	8.0	3.2	2.2	339

The sources have been calibrated at the National Institute for Standards and Technology (NIST), USA. Thus, the well type chamber calibrations provided by the IAEA yield traceability to NIST.

For the maintenance of the standards, a well type chamber (HDR 1000 Plus, Standard Imaging, USA) and a dedicated electrometer (CDX-2000A, Standard Imaging, USA) are used.

FIGURE 1. The HDR 1000 Plus well type chamber and the CDX-2000A electrometer.

The constancy of the output from the standards is checked frequently and always prior to a well type chamber calibration. The calibration factors are valid at the ambient conditions of 20°C and 101.3 kPa.

[1] The CDCS J5 source consists of 9 active pellets, each with a 1.5 mm diameter. The CDC1100 consists of a single active pellet with 2.2 mm diameter.

For air cavity chambers, the International Commission on Radiation Units and Measurements (ICRU) recommends that the measured charge or current be corrected for the presence of water vapour in the air. The recommended correction factor is 0.997 for measurements in an external ^{60}Co beam and at ambient RH between 20% RH and 70% RH. A similar recommendation does not exist for well type chamber dosimetry, and consequently, no correction is applied for the presence of water vapour in air.

2. RESULTS OF THE CONSTANCY CHECKS

The constancy checks of the IAEA standards for brachytherapy dosimetry have been performed since the service became available.

Figure 2 shows the results of the constancy checks with the CDC1100 source that was used. The results are similar to the CDCS J5 source, but for clarity, these results have been omitted from the figure.

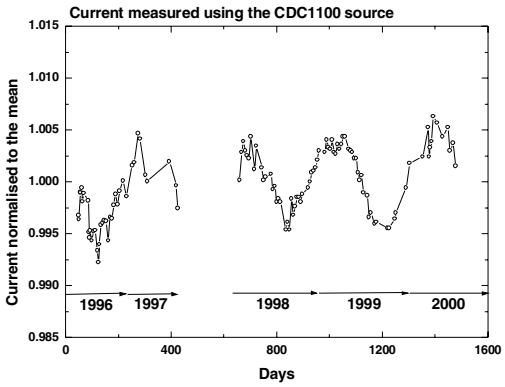

FIGURE 2. Measured current with one of the IAEA standards.

The values shown in Figure 2 have been corrected for the ambient temperature and pressure and for the source decay, using the half-life of 30.17 years for ^{137}Cs. As mentioned above, the values have not been corrected for the ambient RH.

The years in the figure refer to the year of measurement.

The variation in the measured current is apparently periodic, with a period length of approximately one year. The amplitude in the variation is of the order of 0.5%, i.e. the difference between the maximum and minimum values is about 1%.

The inner wall of the HDR 1000 Plus is partially made of a plastic[2] that is known to be slightly hygroscopic. It was therefore decided to measure the ambient RH during each occasion when the constancy of the standards was checked. For the measurement of the RH, two calibrated hygro/thermometers (Testo 454, Testo, Austria) were used. The detectors are programmable and the RH and temperature is read at pre-selected intervals. For processing and analysis of the data, Excel or similar programs can be used.

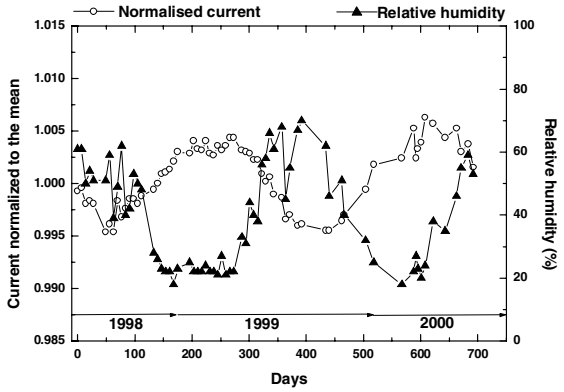

FIGURE 3. Measured current and the relative ambient humidity in the irradiation bunker.

The results of the measured current and the RH in the irradiation bunker are shown in Figure 3. The figure suggests a relation between the measured current and the ambient RH. When the RH is high, the current is low and vice versa. The RH in the irradiation bunker varies from approximately 20% RH to 75% RH, the low values being during the dry winter season while the higher values are reached during the summer. From the figure it also appears that there is a slight shift in the maximum and minimum values of the RH and the current.

3. CLIMATIC CHAMBER MEASUREMENTS

In order to see the effect of the humidity on the measurements with the HDR 1000 Plus well type chamber, experiments were carried out in a Climatic Chamber[3] (Sanyo, Gallenkamp, Germany) in which it is possible to vary the RH between approximately 20% RH to 90% RH. It is also possible to vary the temperature, however, during the present measurements it was set to a constant value of 20°C.

FIGURE 4. An overview of the measurement set up in the Climatic Chamber.

In Figure 4 an overview of the measurement set up in the Climatic Chamber is shown. The humidity in the chamber is controlled by means of an internal hygrometer. When the humidity starts to decrease, distilled water is humidified and injected into the working volume of the chamber. The temperature is kept at a constant level with cooled turbulent air that circulates in the chamber.

The chamber is relatively well sealed, but has some openings so that the air pressure inside the chamber is kept at the ambient value. The RH and the temperature in the Climatic Chamber were measured with the two Testo 454 detectors, using a sampling interval of 15 minutes.

Before the experiments started, the thermometers were compared with one of the Dosimetry Laboratory's working standard mercury thermometers. The agreement was found to be within 0.2°C. In order to verify that the hygrometers gave the same readout, they were placed next to each other and a comparison was made at different RH levels. The agreement was within 0.5% RH.

[2] Cellulose Acetate Butyrate.
[3] Also known as an Environmental Chamber

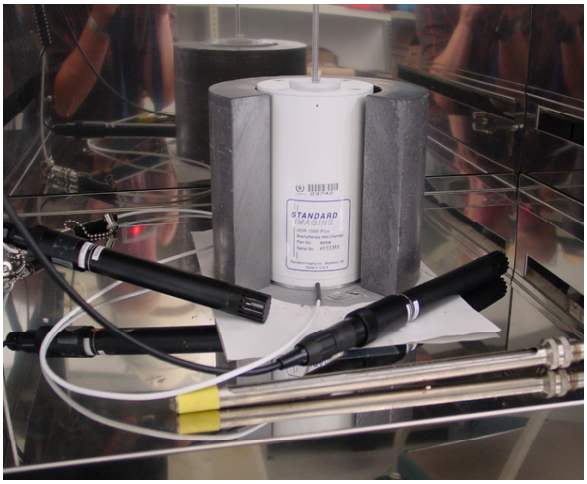

FIGURE 5. Details of the measurement set up in the Climatic Chamber.

In Figure 5 details of the measurement set up inside the Climatic Chamber are shown. During the measurements the hygrometers were placed on opposite sides of the well type chamber. In front of the well type chamber is the Hg-thermometer, which was also set close to one of the hygro/thermometers in order to verify the temperature determined by the Testo 454.

During the experiments, the two Testo 454 detectors showed a temperature difference of 0.8°C across the well type chamber. This indicated that there was a temperature gradient across the well type chamber. Because the RH is temperature dependent, a humidity gradient, 0.8% on average, also existed across the well type chamber. The gradient was constant, i.e. independent of the RH in the Climatic Chamber, and therefore does not affect the final conclusions.

Two sources of different energies were used in the experiments; a ^{137}Cs (photon energy approximately 662 keV) and a ^{241}Am (photon energy approximately 60 keV). The activity of the ^{241}Am source was rather low (approximately 13mCi) and therefore, a more sensitive electrometer (Unidos E, PTW, Germany) than the standard electrometer for brachytherapy dosimetry was used. The reason for using two different energies was to determine any possible energy dependence in the final results.

A dummy source is also seen in the well type chamber. The dot on the upper part of the well type chamber is a vent hole so that the chamber's internal air is kept at ambient conditions with respect to temperature, pressure and humidity. Before the measurements in the Climatic Chamber started, the backscatter of photons from the lead shield was measured. This was done by placing a source inside the well type chamber and measuring the charge with and without the lead shield in place. The backscatter was only 2%. The reason for measuring the backscatter was to estimate whether the electron fluence inside the air cavity, with the lead shield in place, would be representative for the electron fluence under those conditions that exists during the periodic checks.

The source was positioned into the well type chamber only when a measurement was to be made. This means that the door to the Climatic Chamber had to be opened for a short time, changing the humidity inside. It took, however, only a few minutes for the Climatic Chamber to reach the RH it had before the source was inserted into the well type chamber. The relative humidity and the temperature were read before and after each measurement. Because of the temperature and humidity gradient across the well type chamber, average values were used. The temperature was set to 20°C for all RH levels. During the period in which the measurements were made, the temperature in the Climatic Chamber varied only slightly (0.5°C). At each RH level, the well type chamber was allowed to saturate over a few days, as it was suspected that the saturation time for this chamber might be long. The saturation time was between 3-7 days. During this saturation time, when the RH was kept constant, measurements were made in order to find whether there were any trends in the measured currents. No such trends were found. Each series of measurements consisted between 5 and 10. The standard deviations in the measurements were generally below 0.1% (reaching 0.2% once) when using the ^{241}Am source and always below 0.05% when using the ^{137}Cs source.

The relative humidity and the temperature were read before and after each measurement. Because of the temperature and humidity gradient across the well type chamber, average values were used.

4. RESULTS

The quantity 'relative humidity' alone does not uniquely determine the amount of water vapour in air, but must be stated together with the ambient temperature. From a physical point of view, a more correct way would be to plot the current as a function of partial pressure of water vapour in the air. In the present case, however, the temperature

varied only slightly during the period in which these experiments were done. Therefore, the graphs, whether plotted as a function of RH or partial pressure of water vapour, do not differ significantly. Figure 6 shows the normalized current as a function of RH. In Figure 7 the normalized current is shown as a function of the partial pressure of water vapour in the air. As can be seen, there are no significant differences in the graphs. The saturated partial pressures of water vapour were taken from [2].

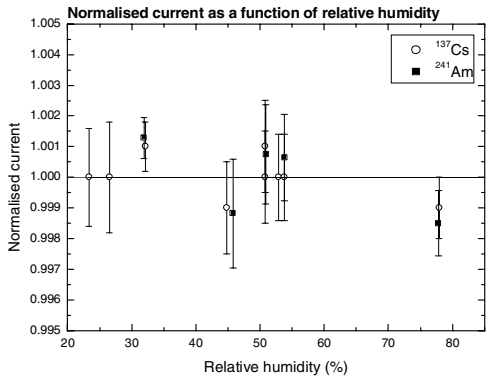

FIGURE 6. Normalized current as a function of relative humidity.

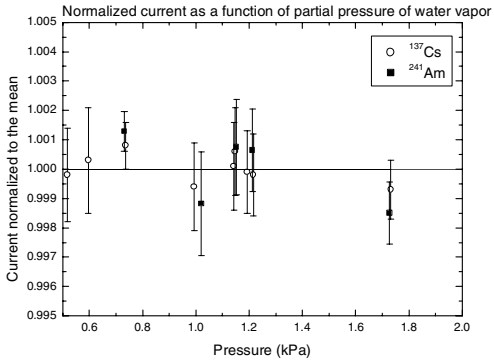

FIGURE 7. Normalized current as a function of partial pressure of water vapour in air.

5. CONCLUSIONS

The variations in the normalized currents, as presented in Figures 6 and 7, is only of the order of 0.1% and are well within the estimated experimental uncertainties. Based on these results, it is concluded that the presence of water vapour in the active air volume of the well type chamber does not have a significant effect on the measured current.

6. FINAL REMARKS

It is important that the periodic variation of the output be solved. In order to find out its cause, the SSDLs possessing a well type chamber are asked to perform similar frequent constancy checks and report the results to the IAEA. The following should be stated in the report:

1. Measured currents (or charge) corrected for temperature and pressure and source decay with a statement of the used half-life.
2. Dates of measurement. It is recommended that the measurements be done frequently, preferably on a weekly basis, or at least twice a month, for a period of approximately 6 months.
3. Type of source used in the constancy checks (e.g. ^{137}Cs, ^{241}Am) including its strength (e.g. in terms of reference air kerma rate, air kerma strength, apparent activity or any other quantity).
4. Electrometer model.
5. Type of well type chamber. Note that the request is not limited to identical well type chambers as that at the IAEA Dosimetry laboratory, nor is it limited to chambers that are open to ambient conditions. Thus, also sealed chambers can be used in the measurements.

A summary of the results will be presented in a forthcoming issue of the SSDL Newsletter. The contributors will be acknowledged.

7. REFERENCES

[1] International Commission on Radiation Units and Measurements (ICRU); Average Energy Required to Produce An Ion Pair. ICRU Report 31, Washington, D.C., U.S.A., 1979.

[2] CRC Handbook of Chemistry and Physics, 80th Edition (Ed. D. R. Lide, CRC Press, Washington DC, 1999).

DEVELOPMENT OF A QUALITY ASSURANCE PROGRAMME FOR RADIATION THERAPY DOSIMETRY IN DEVELOPING COUNTRIES

Report of the second Research Co-ordination Meeting - RCM-650.2 on the CRP E2 40 07
4-8 December 2000, IAEA DMRP Section, Vienna

External Participants were:

Dr M.E. Castellanos, Colombia
Ms. N. Lingatong, Philippines
Mr. R. Campa Menendez, Cuba
Prof. A. Dutreix, France
Prof. B. Gwiazdowska, Poland
Dr Dang Thanh Luong, Viet Nam

Participants from IAEA were:

J. Izewska (scientific secretary)
A. Meghzifene
P. Bera
S. Vatnitsky

1. SUMMARY

The aim of the Co-ordinated Research Programme "Development of a Quality Assurance Programme for Radiation Therapy Dosimetry in Developing Countries" (E2-40-07) is to establish national Quality Assurance (QA) networks for external quality audits for radiotherapy hospitals in developing countries. This is done by setting-up national External Audit Groups (EAG) with laboratory backup for operating TLD audits for radiotherapy dosimetry. The CRP offers a standardized methodology, the same for all participating countries, provides guidelines and gives technical support to the national EAG activities.

In 1995-1998, the national EAGs were established in Algeria, Argentina, China, Czech Republic, India, Israel and Malaysia. At present five countries have joined the project: Colombia, Cuba, Philippines, Poland and Viet Nam.

The current status of the development of methodology and procedures for QA audits in the participating countries was presented and discussed at length. Each participant has submitted the status report regarding the TLD system, measuring procedures, structure of the national EAG and relations with other relevant national organizations or bodies. The new participants are in the process of adapting the procedures developed by the IAEA and revised by the previous group in this CRP. The participants have received information on state of the art of the quality audit networks in Europe presented by Prof. Dutreix.

Further discussions followed the presentations of the results of testing of the EAG measuring systems and operational procedures for audits. Special emphasis was given to issues related to legislation and national regulations in the different countries and confidentiality in reporting the audit results. Procedural problems related to endorsement of the EAGs by the relevant national bodies were noted. The composition of the national EAGs was discussed and optimal structures for the individual countries recommended. The contents of the QA manuals for the EAGs, in preparation by the participants, were also discussed. The recommendations were given for organisation of the audits and follow-up procedures whenever large discrepancies in calibrations of clinical beams were detected.

A document entitled "Guidelines for the preparation of a Quality Manual for External Audit Groups on Dosimetry in Radiotherapy" (IAEA internal report DMRP-9806) has been reviewed and specific recommendations given to the participants. The document is being used as a guide for preparation the quality manual for national EAGs. The "Guidelines ..." include the quality policy, quality systems and quality structures including process control as it is stated in recommendations of ISO 9000 series and ISO/IEC guide No. 25. The standard operation procedures of the Agency's Dosimetry Laboratory for the TLD audits, including maintenance of the TL reference dosimetry system for radiotherapy and operation of the TLD audits (IAEA internal reports DMRP9809 and DMRP9810) were presented as a reference material for the CRP participants.

The working schedules for the five countries were co-ordinated and goals to be achieved outlined with regard to the subsequent implementation steps of the national QA programmes. As the closure of the

CRP is planned in 2001, the plans for publications of the results achieved by different countries were discussed.

2. BACKGROUND

In 1994 a group of consultants was invited to advise the Agency on expansion of the IAEA/WHO TLD postal dose check service for radiotherapy hospitals by the transfer of methodology to national level. The consultants advised the Agency to initiate the Co-ordinated Research Programme (CRP) to adapt the IAEA well established TLD procedures to the countries where existing resources enabled the set up of the External Audit Groups - nationally recognised groups in charge of operating external quality audits for radiotherapy dosimetry. The External Audit Groups (EAG) include the SSDL, a TLD Measuring Centre (MC) and a Medical Physics Group (MPG); these groups work in close co-operation during all steps of implementation of the TLD audits.

The scientific scope of the CRP involves the following implementation steps, which have been planned for accomplishment:

- Set-up national External Audit Groups (EAG) in charge of quality audits for radiotherapy dosimetry.
- Development of the methodology and procedures for national TLD audits of radiotherapy hospitals in the participating countries following the Agency's guidelines.
- Development of the EAG Quality Manual (quality policy, quality system and quality practice)
- Implementation of national TLD audits of radiotherapy beams in hospitals.

The pilot countries, which have been chosen for the CRP were: Algeria, Argentina, China and India. Due to increasing interest in the programme, the Czech Republic, Israel and Malaysia joined the CRP in 1996. The first four countries, whose contracts started in 1995, have successfully completed their projects and continue the national TLD programme on routine basis. Three participants, whose contracts started in 1996, continue the implementation of their national TLD programmes without further financial assistance from the Agency. The Agency preserves the links with the national EAGs in these countries to co-ordinate their activities and to update their techniques and procedures. On the request by Member States to further expand this CRP, five new countries joined the project in 1998. These are: Colombia, Cuba, Philippines, Poland and Viet Nam.

3. DISCUSSIONS

The aim of the meeting was to discuss the degree of implementation of national Quality Assurance programmes for radiation therapy dosimetry as reported by the participants from Colombia, Cuba, Philippines, Poland and Viet Nam, to co-ordinate procedures and discuss developments. The EAGs are being set-up and their structure, responsibilities and interactions between the EAG partners established. The approval by the Ministry of Health (or equivalent national body/ organization) for conducting joint activities between the medical and nuclear energy authorities towards Quality Assurance (QA) in radiotherapy needs to be obtained for most countries. The trial quality audit runs with a selected number of hospitals were performed.

The review of the implementation status, experiences and achievements of the CRP during 1995-1999 were presented by the scientific secretary. The EAG methodology and procedures as developed by the CRP were discussed with the five new participants.

4. STATUS REPORTS FROM THE PARTICIPANTS

A presentation of the recent developments of the European projects on external audits was given by Prof. A. Dutreix. Other participants have presented their status reports on the implementation of the CRP in their countries. Each participant has submitted a written contribution, that are presented below:

A. Dutreix, France

The ESTRO Quality Assurance network for radiotherapy (EQUAL) was set up in 1998 in cooperation with the IAEA, for ESTRO members, primarily from the countries of European Union. The network is sponsored by the European Union and deals with mailed TLD audits of photon and

electron radiotherapy beams both for reference and non-reference conditions. For photon beams, TLD checks include the reference beam output, beam output variation with collimator opening, depth dose data and wedge transmission factors. For electron beams, the programme includes reference beam output measurements for three field sizes (10 cm x 10 cm, 15 cm x 20 cm and 7 cm x 7 cm).

So far the EQUAL programme has checked 757 photon beams in 282 hospitals, of which 11% were ^{60}Co beams and 89% were X-ray beams. The results show that 1.4% of the reference beam outputs and 3% of the percentage depth doses are outside the tolerance level (deviation outside ±5%). Five percent of the beam outputs variations and 4% of the wedge transmission factors show deviations outside ±5%. The deviations outside ±5% occur for at least one parameter in 133 out of the 757 beams, mainly for large and rectangular fields and for wedged beams; 45 results of 133 of the rechecked beams confirm a significant dosimetry problem for one or more beam parameters, corresponding to 7% of all checked beams.

The EQUAL has checked 97 centres with 277 electron beams, 48% of low energy beams (≤ 10 MeV) and 52% of high energy beams (> 10 MeV). Approximately 1.0% of results for the reference beam output (10 cm x 10 cm) and about 2% for output at other field sizes are outside tolerance level of ±5%. However, the percentage of deviations between 3% and 5% for the reference beam output for electron beams is about three times higher than for photons.

The EQUAL programme proofs that the results for the reference beam output for photon and electron beams are good and high consistency in radiotherapy exists between European hospitals.

E. Castellanos, Colombia

Colombia is a country of approximately forty million inhabitants. Fifteen provincial capitals, located in the most populated region have radiotherapy services. There are thirty-one radiotherapy services in the country, from which fourteen with medical physics department. Those radiotherapy services are equipped with twenty eight cobalt units, fourteen linear accelerators (with nineteen photons beams), eight treatment simulators and thirteen radiotherapy planning systems. Twenty-two physicists are involved with radiotherapy services, 10 with specialised medical physics education.

There is in the country one Secondary Standard Dosimetry Laboratory (SSDL) which belongs to the IAEA/WHO SSLD network, in INGEOMINAS (Instituto de Investigación e información geocientífica, mineroambiental y nuclear). This SSDL takes part in Co-ordinated Research Program (CRP) E2.40.07 of the IAEA with the RC titled "Creation of a national TLD network for beam calibration and dosimetric parameters quality control in radiotherapy", which lasts now one year. The scope of the project is to set up a national QA program for radiotherapy dosimetry, involving the co-operation between the existing SSLD and hospital medical physics and radiotherapy departments.

To start carrying out the project INGEOMINAS counted with the infrastructure of the SSDL, one Harshaw 6600 TLD reader, one TOLEDO TLD reader, two ovens and 250 g of TLD 700, donated by the IAEA. Two physicists were involved with the RC. During the first year of the contract the work and research relevant to the CRP was the following:

- Creation of External Audit Group (EAG) in the SSDL composed of four physicists
- Study and discussion of the TRS 277 of the IAEA for calibration of radiotherapy units and of the TLD technique, directing the exercise towards the training of junior physicists
- Purchasing of the auxiliary equipment: precision balance, minor laboratory supply and an interface to obtain in the computer the heating and the glow curves from the TOLEDO reader
- Evaluation of the operation of the TOLEDO reader and HARSHAW ovens in the laboratory using TL-100 chips (some repairs were necessary)
- Definition of the set-up of calibration and irradiation of the TLD powder and study of the influence parameters in the results of measurements: TL response as a function of the mass of the sample, TL response as a function of the dose and fading
- Drawing up of the of the QA manual "Implementation of a TLD measure system for external radiotherapy beam calibration external

audit", which is an adaptation of the manual DOLP.004 "Maintenance of the Thermoluminiscence (TL) Reference Dosimetry System for Radiotherapy", from the IAEA.

- Internal trials of dose evaluation using the complete system and preparation of instruction and data sheets for the postal dosimetry audits
- Arrangements to extension of the EAG with medical physicist from all over the country
- First run of postal dosimetry audit with hospitals taking part in the EAG.

During the first meeting of the EAG the results of the first run will be analysed, and an action plan for 2000 accorded, including arrangements for the formal endorsement of the national EAG by the appropriate governmental bodies (Ministry Energy and Ministry of Health) so that the work of the group was recognised at national level.

In conclusion, the work plan accorded for the first year was accomplished although some activities were further carried out.

Before the project closure, the EAG will perform internal trials runs to evaluate the TLD systems uncertainties, to complete the TLD procedures for external audits of high energy photon beams, to perform the intercomparison of the TLD system calibration with the IAEA laboratory and to complete the EAG manual.

R. Campa Menendez, Cuba

The participation of Cuba in National and Regional Technical Assistance Projects of the IAEA in Quality Assurance in Radiotherapy (ARCAL XXX and CUB/6/011) has allowed passing to a superior stage in the process of the quality assurance, the establishment of a National Quality Audit Program (PNAC) in the physical aspects. The National Control Center for Medical Devices as national regulator entity for the control and supervision of the medical devices of the National Health System is the responsible for the implementation of this program. Specialists from this Center together with ones from the National Institute of Oncology and Radiobiology (INOR) and the Center for Hygiene and Radiation Protection (CPHR) carries out the activities of this program, integrated in the National Audit Group (EAG), constituted to performing quality audit for radiotherapy dosimetry, whose aim is to ensure adequate precision in the dosimetry of clinical beams. This National EAG is in charge or is responsible for the execution of the quality audits to the radiotherapy service, through visits as well as with TLDs postal way.

In the context of this project (RC No: 10794) it was developed, as it is recommended by international standards (ISO/IEC Guide No: 25), a Quality Manual Draft for Dose Audit in reference conditions using TLDs to Co-60 units with the following contents: quality objective, quality policy, service organizational outline and responsibilities system, control of documentation and data, control of certificates and treatment of nonconformities. This manual calls some reference documents, including work instructions, records and forms. Thermal treatment cycle to be used in preparation of the TLDs was optimized to obtain accurate results. Individual calibration factors were determined for the TL detectors (LiF-rods) in the 4 cycles of irradiation and readout. They varied by less than 2% for all TLDs. An external trial dose determination using the IAEA TLD service was carried out after an internal trial using the SSDL/CHPR irradiation service and in both cases the differences obtained were within 1%. A pilot TLD audit was carried out for five beams in Cuban radiotherapy centers. The TLDs were placed for irradiation in a NE 2528/3 phantom, available in each radiotherapy department, using special acrylic inserts fitting to the build-in chamber holders. The differences between the user stated dose and the dose measured with TLDs were within ± 5% for all checks.

N. Lingatong, Philippines

The project for the Philippines is entitled "National TLD Postal Dose Intercomparison Program for Teletherapy Centers in the Philippines". The program is designed to include two annual activities: on-site visits for radiotherapy quality audit and local dose quality audit runs.

The members of the External Audit Group were selected by the project personnel from qualified local practitioners, giving considerations to the following inclusion criteria: extensive training and experience in radiotherapy applications (external beams and brachytherapy), pro-medical physics (for radiation oncologists only), dedication, integrity and workload.

The Medical Physics Group and the Radiation Oncologists' Group are composed of clinical practitioners from both government and private institutions. The Measuring Group is composed of technical personnel from the RHS-SSDL and PNRI

SSDL. The designated Measuring Center is the RHS SSDL.

After the organization of the EAG, the project started with the site visits involving performance testing and full calibration of teletherapy machines nationwide. A form was drafted for data gathering that is at present undergoing modifications to include information which may be of help in the preparation of developmental plans by the DOH.

The implementation of the project did not encounter any major difficulty at the management level of the lead government agencies that are financially supported by the Philippine government. At the local radiotherapy centers, the project gained a high degree of acceptance because all centers are regular participants of the IAEA/WHO TLD Postal Dose Audit Program which is coordinated by the RHS-SSDL.

The first activity of the on-site visit is a briefing conference attended by the radiotherapy personnel and the Medical Director or Hospital Administrator to give an overview of the program of the visit. The audit is carried out without affecting the normal flow of activities in the department. An exit conference is also held to inform the concerned parties about the results of the audit and come up with recommendations to further improve the quality of service of the department.

The TLD Measuring Group has gathered adequate information on the status of the teletherapy machines, dosimetry, workload, manpower, radiation safety and the status of quality assurance implemented in each facility. All centers have existing quality assurance programs operating at different levels, ranging from simple periodic machine spot checks required by regulation to a very comprehensive one. This however, is dependent on the availability of a medical physicist in these facilities. At this stage all the medical physicists and radiotherapy technologists were also trained how to properly set-up and irradiate the TLD capsules in preparation for the local TLD run. The centers were also provided one set each of the standard IAEA tripod holder for future use.

In September of 2000, the RHS-SSDL sent TLD capsules to the IAEA-DMRP for irradiation and intercomparison with its TLD system. The evaluation results of the blind test show that the estimated dose agrees within 0.7% with that of the IAEA. However, there are still some points in the Guidelines that need more clarification in order for some procedures to be ironed out to suit local instrumentation and situation.

Forms for the national TLD intercomparison are being drafted by the project personnel. The IAEA forms have been modified to include only the data which are applicable to the local setting and simplified to be easily comprehended by the local radiotherapy personnel and requiring little time to accomplish.

A pilot run for the TLD dose quality audit has been scheduled for February 2001. The national TLD run for all beams will take place in May 2001.

B. Gwiazdowska, Poland

The Therapy-level Secondary Standard Dosimetry Laboratory, SSDL, at the Medical Physics Department of the Centre of Oncology in Warsaw has been operating since 1966. In 1988, on the recommendation of the Polish Primary Standard Dosimetry Laboratory, the Polish SSDL was incorporated into the IAEA/WHO Network of the SSDLs. The Polish SSDL performs calibrations of radiotherapy dosimeters for all radiotherapy centres in Poland, prepares dosimetry and quality assurance recommendations, performs on-site calibrations of the beams, and organizes training activities for medical physicists. In 1990 the SSDL started TLD intercomparison programme of absorbed dose for megavoltage therapy units in Poland. This activity has been continued during the period 1993-1996 in the framework of the EROPAQ project (pan-European Radiation Oncology Programme for Assurance of Treatment Quality).

On the basis of the above mentioned experience, the External Audit Group in charge of TLD based quality assurance network for teleradiotherapy in Poland was established in 1999. This activity is recognized and commended by the National Consultant in Radiotherapy Oncology (further legal regulations concerning the quality assurance in radiotherapy, following the EC recommendations according to the Council Directive 97/43/Euratom, are in preparation by the Polish Ministry of Health.).

The computerized data base on the infrastructure of radiotherapy in Poland has been updated in 2000. There are 43 accelerators, 22 Co-60 units, and 9 orthovoltage X-ray units in 21 centres that perform megavoltage teletherapy (for a total population of about 40 millions). All centres have at least one physicist responsible for dosimetry and at least one

dosimeter calibrated at the SSDL (7 centres have two or more).

The TLD laboratory, manned by the EAG members, is a part of the Medical Physics Department and functions closely with the SSDL. The TLD system consists of a Harshaw TLD reader (2000C), coupled with a modified Harshaw picoammeter. It uses MT-N powder (LiF:Mg,Ti) from Niewiadomski Co. (Poland). Holders and waterproof capsules were obtained from the IAEA. The capsules contain typically about 200 mg of LiF, allowing for 9-10 readings per capsule.

Before the audits started, the reading conditions of the TLD system were established and the adequate parameters determined: calibration coefficient for Co-60 radiation, dose response linearity factor, fading and energy correction factors, as well as the reader's drift correction.

The dose measurements were performed with a 0.6 cm^3 NE 2571 ionization chamber that was coupled with the Farmer Dosimeter 2570/1. The chamber together with the electrometer was calibrated by the SSDL.

The TLD audit run in 1999 was carried out (on a voluntary basis) for 12 Co-60 units. Measurements and methodology, as well as instructions and data sheets fulfilled, in principle, the recommendations of the IAEA ("Maintenance of the thermoluminescence reference dosimetry system for radiotherapy", DMRP9809, and "TLD postal dose quality audit service for external radiotherapy", DMRP9810).

The distribution of the results has the mean value of +0.2% with the uncertainty of 1.5% (1 SD). In eight cases the results are below 1%, and in three cases below 2%. The deviation of the averaged results exceeds 3.5% only in one case.

However, the results for individual capsules may vary considerably, e.g. exceeding 3% or even 5% for two beams. In the latter case, the individual values resulted in an average deviation equal to 0%.

The results of the three audits performed for Co-60 units in 1991, 1994 and 1999 show improvement in the subsequent years. It proves that external audits effectively contribute to quality assurance in radiotherapy.

The proposals for next steps of the working plan will include expansion of the TLD audit to the megavoltage X-rays, drafting the Quality Manual for the Polish EAG, for which a number of appendices have already been prepared, e.g. TLD instruction and data sheets, forms for reporting the TLD results to the participants.

Dang Thanh Luong, Viet Nam

There are 9 radiotherapy departments in Viet Nam (2 new departments were established in 2000) for the population of 76 million. These departments are equipped with 13 teletherapy Cobalt-60 units, 8 low dose rate Cs-137 and 1 high dose rate Co-60 brachytherapy units. Furthermore, 3 linacs are planned to put into the operation, one is under commissioning, two are under construction.

The EAG has been set up. The following staff members were invited to EAG: 6 physicists including 3 staff members at the SSDL and 3 staff members in TL Measuring Group, and a technician from the Radiation Protection Center. In addition 2 medical physicists from K and Ha Ba Trung Hospitals were invited to participate in the EAG activities. A radiation oncologist will also be invited to join the EAG.

The TLD measuring system and procedures have been developed and tested. The TLD repeatability and calibration tests were performed. The intercomparison with the IAEA has been done. The TLD pilot audit run was performed with 4 hospitals for Co-60 beams.

It is planned to complete three documents: the Quality Manual for the EAG on Dosimetry in Radiotherapy, TLD Postal Dose Quality Audit Service and Maintenance of the TLD System.

Further plans will involve establishing the measuring procedures including: check of the reproducibility of TL readings (stability tests of the Harshaw 4000 TLD reader , reproducibility test using the stainless steel cupels), new calibration of the TLD system (2 or3 series of calibration using the IAEA reference irradiations planned in January to February 2001), fading test.

Next implementation step will involve performing the TLD runs for all radiotherapy departments in Viet Nam that are scheduled from March to June 2001. Every second year on-site visits to radiotherapy hospitals are planned. The detailed programme will be described in the QA Manual.

5. IMPLEMENTATION OF THE "GUIDELINES FOR THE PREPARATION A QUALITY MANUAL FOR EXTERNAL AUDIT GROUPS ON DOSIMETRY IN RADIOTHERAPY"

The EAG Quality Manual "Guidelines for the preparation a Quality Manual for External Audit Groups on Dosimetry in Radiotherapy" was drafted during the Consultants Meeting, held on 11-14 November 1996. The document was developed to help achieving uniformity among different EAGs, to facilitate exchange of experiences and follow ISO 9000 and ISO/IEC Guide 25. The draft of "Guidelines..." was thoroughly reviewed during the first RCM.

In the present RCM the implementation of the "Guidelines…" was discussed and specific recommendations given to each participant to address the needs expressed in their reports. Main emphasis was given to the composition and organisation of the national EAGs. The need for the participation of a radiation oncologist recognized by the medical community in the country was emphasised. This was followed by a detailed discussion regarding the organization of audits, reporting the results and the follow-up procedure for the deviation outside the acceptance limits. The problem of confidentiality with relation to the national legislation (or state regulation) was carefully considered.

6. FUTURE DEVELOPMENT AND IMPLEMENTATION STEPS

The discussion of future plans began with consideration of the measurements which could be done before the end of the project in 2001, first to assure good quality of the work of the TLD Measuring Centres and secondly to extend the services offered by the EAG to the hospitals. The working schedules for individual participants were co-ordinated and goals to be achieved related to subsequent development and implementation steps of the CRP. After successful accomplishment of implementation of the methodology for the individual QA programmes in participating countries, the TLD audits will be offered to all radiotherapy hospitals in the country on a regular basis provided the adequate resources are allocated by the relevant authorities. The participants will complete their QA Manuals for the national EAGs according to the "Guidelines…" prepared within the E2.40.07 CRP.

With respect to the plans for 2001, the TLD audits of the MCs are included in the IAEA/WHO TLD annual runs for the SSDLs. In addition, the Agency's Dosimetry Laboratory will irradiate several sets of reference TLDs to be evaluated by each of the EAGs. The results obtained within the duration of this CRP should be presented in international conferences and the corresponding papers submitted to national or international journals for publication.

7. RECOMMENDATIONS TO THE IAEA

1. The IAEA, through its TLD audit programme, will preserve the links with the national EAGs to co-ordinate their activities and to update their techniques and procedures beyond the completion of the CRP in 2001. A support to the national EAGs with a minor laboratory supply will be provided.
2. The IAEA will make available to the EAGs the appropriate Agency's documents and reports.
3. On the request of the individual EAGs, the reference irradiations by the IAEA Dosimetry Laboratory will be provided.

COURSES AND MEETINGS TO BE HELD DURING 2001

Training courses in the field of dosimetry and medical radiation physics

- February 5-9 RCA Regional Training Course on Treatment Planning in Clinical Radiation Oncology, Melbourne, Australia (RAS/6/027)
- June Comprehensive Quality Assurance Programme in Radiotherapy, Ulaanbaatar, Mongolia (one week, dates to be fixed) (MON/6/011)
- September 10-14 RCA Regional Training Course on Radiobiological and Physical Aspects of LDR and HDR Brachytherapy in Uterine Cervix Cancer, Jaebashi, Japan (dates to be confirmed) (RAS/6/035)
- October 21-25 Workshop on Quality Control and Maintenance of Dosimetry Systems, Khartoum, Sudan (RAF/6/027)
- November Quality Assurance and Quality Control in X-ray Diagnostics, Yerevan, Armenia (two weeks, dates to be fixed) (ARM/6/004)

ESTRO courses under RER/6/012:

- March 25-29 Radiotherapy Treatment Planning: Principles and Practice, Dublin, Ireland
- March 27-31 Modern Brachytherapy Techniques, Paris, France
- April 22-26 Clinical Research in Radiation Oncology, Izmir, Turkey
- May 20-24 Dose & Monitor Unit Calculations for High Energy Photon Beams, Basic Principles and Application to Modern Techniques, Coimbra, Portugal
- June 24-28 Imaging for Target Volume Determination in Radiotherapy, Krakow, Poland
- August 29- Sept 2 Modern Brachytherapy Techniques (with Russian translation), Bratislava, Slovakia
- August 26-30 Physics for Clinical Radiotherapy, Leuven, Belgium
- October 7-11 Evidence-Based Radiation Oncology; Principles & Methods, Cairo, Egypt
- October 7-11 Basic Clinical Radiobiology, Tenerife, Spain

Meetings

- Consultants' meeting on "Calibration of air cavity chambers for Ir-192 quality. Updating of TECDOC-1079". IAEA Headquarters, Vienna, 7-11 May 2001.

- First Research Co-ordination Meeting on dosimetry in X-ray diagnostic radiology: An International Code of Practice. IAEA Headquarters, Vienna, 14-18 May 2001.

- Second Research Co-ordination Meeting on EPR biodosimetry (E2.40.11). IAEA Headquarters, Vienna, October 2001.

- Consultants' meeting on implementation of a Code of Practice for dose determination in photon, electron and proton beams based on measurement standard of absorbed dose water. IAEA Headquarters, Vienna, November 2001.

- First Research Co-ordination Meeting on the development and dissemination of absorbed dose to water standards by SSDLs. IAEA Headquarters, Vienna. Dates not yet known.

- Consultants' meeting on development of TLD-based quality audits for radiotherapy dosimetry in non-reference conditions. IAEA Headquarters, Vienna. Dates not yet known.

- Consultants' meeting to develop procedures for the acceptance testing and commissioning of radiotherapy equipment (jointly with the Applied Radiation Biology and Radiotherapy Section), IAEA Headquarters, Vienna. Dates not yet known.

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International Bureau of Weights and Measures (BIPM)
International Commission on Radiation Units and Measurements (ICRU)
International Electrotechnical Commission (IEC)
International Organization of Legal Metrology (IOML)
International Organization of Medical Physics (IOMP)

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Physikalisch-Technische Bundesanstalt (PTB)	Braunschweig, GERMANY
National Office of Measures (OMH)	Budapest, HUNGARY
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