International Atomic Energy Agency

ACTIVITIES OF THE DOSIMETRY AND MEDICAL RADIATON PHYSICS SECTION

Activities in 2011 and 2012

ACTIVITIES OF THE DOSIMETRY AND MEDICAL RADIATION PHYSICS SECTION, IAEA

Report on Activities, 2011-2012

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1. INTRODUCTION

The Dosimetry and Medical Radiation Physics (DMRP) section works on the Quality Assurance (QA) aspects of the use of radiation in medicine to ensure that medical procedures involving radiation are performed safely and effectively in Member States. Furthermore, it contributes to the increase in scientific and technical capacity in medical physics worldwide by fostering research and developments in dosimetry techniques and playing a role in the education and training of medical physicists. The primary beneficiaries of these activities are hospital patients undergoing therapy and diagnosis with radiation, radiation workers who benefit from the standardization of radiation protection measurements and the general public due to improved dosimetry practices. DMRP also provides two types of service to Member States: calibration and dosimetry auditing. A Standing Advisory Group denominated “Scientific Committee of the IAEA/WHO Network of Secondary Standards Dosimetry Laboratories (SSDLs)”, was established to review and evaluate the work of the DMRP. The 15th meeting of the Committee took place in Vienna from 12 to 16 March 2012; the report will be published in the SSDL Newsletter No. 61 (in preparation).

The current report includes four appendices:

- Appendix 1: Coordinated Research Projects (CRPs). This appendix lists all CRPs which are active during the reporting period.
- Appendix 2: Training courses. This appendix lists all courses organized or supported by the IAEA in medical physics during the reporting period.
- Appendix 3: IAEA Publications in Dosimetry and Medical Radiation Physics. This appendix lists documents and reports published by the IAEA in medical physics during the reporting period.
- Appendix 4: Non-IAEA publications authored or co-authored by staff members of the IAEA Dosimetry and Medical Radiation Physics (DMRP) Section.

2. OVERVIEW OF PROJECTS IN DOSIMETRY AND MEDICAL RADIATION PHYSICS

During the period 2011–2012, DMRP's programme included four projects, with the titles as indicated, followed by the objectives in each case:

- **Project 2.2.4.1: Quality audits in dosimetry for radiation therapy**

Project objective: To ensure the quality of the dosimetric chain in Member States through an independent means of verification of the calibration of radiation beams used for treatment of cancer patients.

- **Project 2.2.4.2: Calibrations and comparisons in radiation dosimetry**

Project objective: To enhance the capability of Member States to establish and maintain a high level of quality and consistency in radiation measurements that is linked to the international measurement system.

- **Project 2.2.4.3: Quality Assurance and guidelines for medical physics in clinical radiation imaging**

Project objective: To establish and maintain high quality medical imaging capability for diagnosis and related treatment in Member States following appropriate QA programmes with qualified and clinically trained staff.

- **Project 2.2.4.4: Quality assurance and medical physics developments in radiotherapy and therapeutic nuclear medicine**

Project objective: To contribute to new developments, worldwide harmonization and implementation of QA procedures in radiation oncology.

3. SERVICES PROVIDED BY THE IAEA

The IAEA's Dosimetry and Medical Radiation Physics Section focuses on services provided to Member States through the IAEA/WHO SSDL Network and a system of dose quality audits. The measurement standards of Member States are calibrated, free of charge, at the IAEA's Dosimetry Laboratory located in Seibersdorf. The audits are performed through the IAEA/WHO TLD postal dose audit service for SSDLs and radiotherapy centres.

The range of laboratory services provided to Member States covers:

- Calibration of ionization chambers (radiotherapy, diagnostic radiology including mammography, radiation protection).
  Radiation quality: X rays (10 - 300 kV) and gamma rays from ^{137}Cs and ^{60}Co.

- Calibration of well-type ionization chambers for Low Dose Rate (LDR) brachytherapy.
  Radiation quality: gamma rays from ^{137}Cs.

- TLD dose quality audits for external radiotherapy beams (for SSDLs and hospitals).
  Radiation quality: gamma rays from ^{60}Co and high-energy X ray beams.

- TLD dose quality audits for radiation protection (for SSDLs).
  Radiation quality: gamma rays from ^{137}Cs.
- Reference irradiations for dosimeters for radiation protection.
  Radiation quality: X rays (40 - 300 kV) and gamma rays from ^{137}Cs and ^{60}Co.

The IAEA Calibration and Measurement Capabilities (CMCs) are published in Appendix C of Comité International des Poids et Mesures (CIPM), Mutual Recognition Arrangement (MRA).

4. QUALITY MANAGEMENT SYSTEM AT THE IAEA'S DOSIMETRY LABORATORY

A Quality Management System (QMS) has been established for the IAEA's Dosimetry Laboratory (DOL) following ISO Guide 17025: General Requirements for the Competence of Calibration and Testing Laboratories [ISO 1999 with the update in 2005]. The purpose of the QMS is to help ensure quality through documented policies and procedures. The document consists of a Quality Manual followed by several Dosimetry Operating Laboratory Procedures (DOLPs) describing the dosimetry systems that are maintained by the Dosimetry Laboratory and the services that are offered to the Member States (see Section 3 above). A separate DOLP describes the operation and safety aspects of the various irradiation units and sealed sources that are used for calibration of dosimeters.

The initial process of reviewing the Quality Management System of the IAEA's Dosimetry Laboratory was completed in 2006. The "Resolution 17/1" of the Joint Committee of Regional Metrology Organizations and the BIPM (JCRB) confirms acceptance of the DOL QMS. As a consequence, the DOL's calibration and measurement capabilities remained formally included in the BIPM data base. Between 2006 and 2011 DMRP submitted annual reports on DOL QMS to JCRB. Following the recommendation by JCRB, as of 2012 DOL QMS is presented for reviews to the EURAMET TC-Q. Consequently, the annual reports on DOL QMS are submitted to the EURAMET TC-Q. The DOL CMCs have recently been updated and submitted to EURAMET for review. There are 9 new CMC claims in diagnostic radiology and radiation protection.

The DOL QMS undergoes regular reviews and audits, both internal and external. A feedback system is incorporated in the audit schemes in order to monitor the changes and document improvements. The last external peer review was performed by the EURAMET IR expert team in the frame of the EURAMET project #1219 in 2012.

The results of customer satisfaction survey conducted among SSDLs in 2012 suggest that DOL services are perceived as excellent or very good by 95% responders**.**

5. THE IAEA/WHO NETWORK OF SECONDARY STANDARDS DOSIMETRY LABORATORIES (PROJECT 2.2.4.2)

Membership in the IAEA/WHO SSDL Network is open to laboratories designated by their national competent authority. The network presently consists of 84 laboratories in 67 Member States, of which more than half are developing countries. Recently, the SSDL of Kenya, established under a Technical Cooperation project, joined the Network in 2011.

The network includes 20 affiliated members, all of which are international organizations or Primary Standards Dosimetry Laboratories (PSDLs). Most SSDLs provide traceable instrument calibrations for radiation protection, radiation therapy, and in some cases, diagnostic radiology including mammography. Some SSDLs also provide quality audits of radiotherapy beams by postal TLD or on-site measurements, and some perform measurements for nuclear medicine.

The main objective of this project is to provide traceability of measurements by maintaining the link between the end-users of radiation and, through the PSDLs, to the international measurement system. In addition, the project provides quality audit services to verify that the laboratory members follow internationally accepted metrological standards. Since 1981, a postal TLD programme has monitored the performance of the SSDLs for radiotherapy dosimetry. A routine comparison service, using ionization chambers, was initiated in 1997 to verify the integrity of the reference standards of SSDLs in the therapy dose range. In the radiation protection dose range, a regular postal TLD programme has been set up to check the ^{137}Cs and ^{60}Co calibrations provided by the SSDLs.

5.1 TRACEABILITY

The review of the SSDL annual reports for 2011 shows that about 34% of SSDL standards are traceable to SI through the IAEA, 14% SSDLs get their standards calibrated directly at the BIPM and 52% at other PSDLs (see Figure 1).

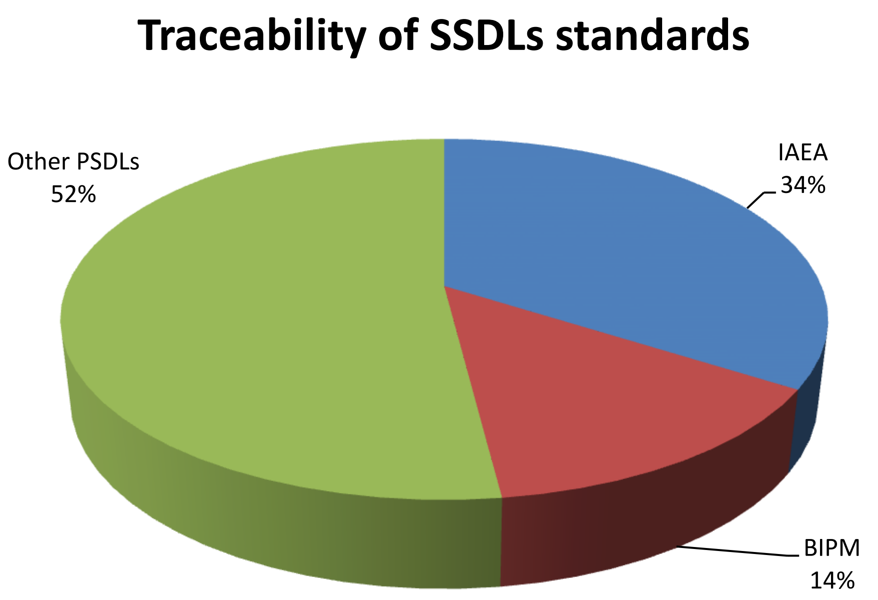

FIG. 1. Traceability in the IAEA/WHO Network of SSDLs.

5.2 IAEA PARTICIPATION IN COMPARISONS

The Agency has participated in the following comparisons organized by Regional Metrology Organizations (RMOs):.

(i) BIPM.RI(I)-S1: Comparison of the air kerma standards of the IAEA and the BIPM in mammography X rays. (report approved and published);

(ii) EURAMET. RI(I)-S3.1 Comparison of air kerma standards for medium-energy X radiation between the MKEH and the IAEA. (report approved and published);

(iii) EURAMET. RI(I)-S9 Comparison of calibration of KAP meters in terms of air kerma area product and DR dosimeters in terms of air kerma. (draft A in progress);

(iv) EURAMET. RI(I)-S10 Comparison of air kerma measurements between the PTB and the IAEA for X ray radiation qualities used in general diagnostic radiology and mammography (draft B in progress);

(v) EURAMET. RI(I)-S5 Supplementary comparison of the personal dose equivalent quantity for photon radiation (report approved and published);

(vi) COOMET.RI(I)-S1: Comparison of the national standards of air kerma for ^{137}Cs at protection level (draft A in progress)

(vii) APMP.RI(I)-K2: APMP Key Comparison of air kerma standards for the CCRI reference radiation qualities and the ISO 4037 narrow spectrum series in the low-energy X ray region (draft B in progress)

(viii) AFRIMETS.RI(I)-S1 Dosimetry comparison for air kerma measurements involving ^{137}Cs, ^{60}Co and X ray beam qualities used for radiation protection level calibrations (measurements are in progress)

5.3 IAEA SUPPORT TO SSDLS

5.3.1 Preparation of guidance documents SSDLs

- *Radiation protection calibrations at Secondary Standards Dosimetry Laboratories:* The update of IAEA Safety Reports Series No. 16 “Calibration of radiation protection monitoring instruments” (in progress).

- *SSDL Network Charter:* The updated version of the SSDL Network Charter will take into account the lessons learned since the first Charter was established, the CIPM MRA that has reinforced the international measurement system, and the ISO/IEC standard 17025 related to quality management systems. By clearly explaining the duties and responsibilities of the SSDLs in order to obtain the privileges of being a Network member, this Charter update should assist the Member States in obtaining and maintaining membership status for their Secondary Standards Dosimetry Laboratories (in progress).

5.3.2 Setting-up and upgrading of SSDLs

The IAEA supports the SSDL Network members through its Technical Cooperation (TC) Programme and its regular budget activities.

- Under its TC Programme, the IAEA is assisting in the establishment of new SSDLs in Armenia, Azerbaijan, Bahrain, Mongolia, Oman, Qatar, United Arab Emirates.

- The IAEA has been also assisting in upgrading SSDLs in Argentina, Bulgaria, Croatia, Colombia, Cyprus, Ecuador, Ethiopia, Guatemala, Israel, Kenya, Macedonia, Moldova, Nigeria, Nicaragua, Oman, Phillipines, Saudi Arabia, Sri Lanka, Syria, Uruguay and Vietnam by introducing new calibration services and/or strengthening their quality management systems**.**

5.3.3 Standardization of dosimetry in X ray diagnostic radiology

Based on a recent review of the activities of national Secondary Standards Dosimetry Laboratories, gaps have been identified in the standardization of dosimetry in X ray diagnostic radiology. In response to this finding, the IAEA convened a Technical Meeting in November 2012 to assess the national calibration capabilities in this field, through an experimental comparison of national dosimetry standards. The experimental comparison was conducted at the Agency's Dosimetry Laboratory using its reference standards as a benchmark for the comparison. The analysis of the results of the comparison will help the participating Member States improve their accuracy of measurements in this field. It is expected that the improved accuracy at the level of Secondary Standards Dosimetry Laboratories will be disseminated through traceable calibrations to end-users in hospitals.

5.3.4 Calibration of national measurement standards

During 2011–2012, the IAEA calibrated for Member States 120 ionization chambers of which about 54% (65/120) were for radiotherapy dosimetry, 24% (29/120) for radiation protection, 20% (24/120) for diagnostic radiology and 2% (2/120) for brachytherapy (see Figure 2).

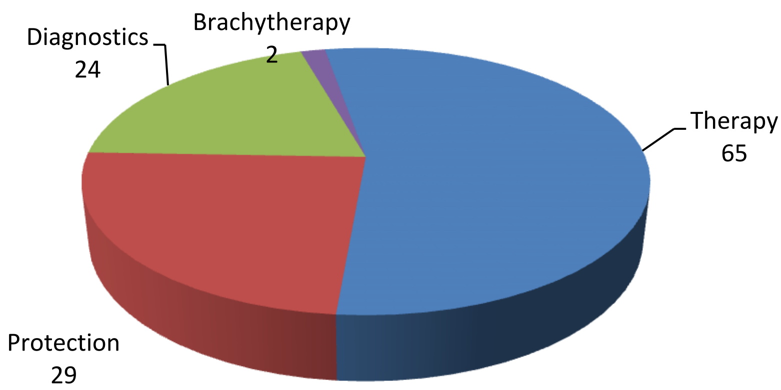

Fig. 2: Number of ionization chambers calibrated between 2011-2012.

The distribution of ionization chamber calibrations coefficients determined at the IAEA during last 12 years is shown in Figure 3. During the last two years a significant increase of diagnostic level calibrations was noticed, which could be attributed to increased demand by SSDLs for diagnostic calibrations.

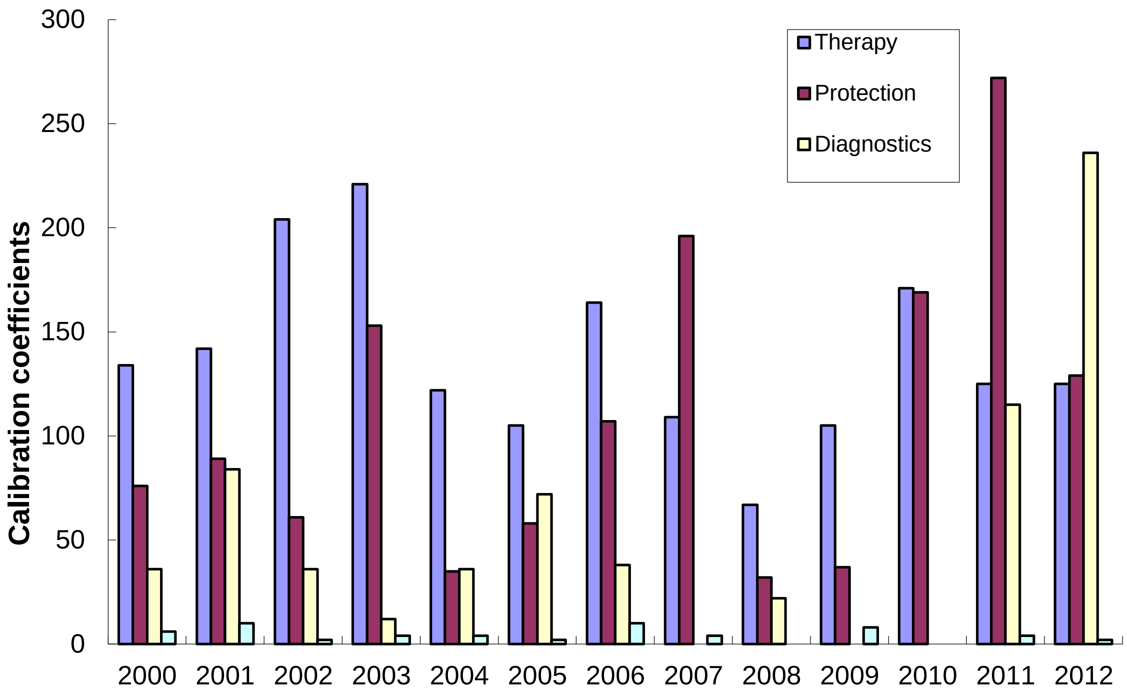

Fig. 3: Number of calibration coefficients determined for Member States' reference standards between 2000-2012.

5.3.5 Calibration for diagnostic radiology

In 2011, the old X ray tube with Mo anode ("glass" type) has been replaced with a new metal ceramic type tube (MCD100H-5 Mo) to improve (i) X ray tube performance (ii) radiation beam homogeneity (see Figure 4). The calibration services for mammography (Mo/Mo and Mo/Rh beam qualities) were resumed in Q4/2011. The calibration procedures were updated in the relevant QMS documents. For the updated IAEA CMC claims, the supporting comparison of air kerma measurements between the PTB and the IAEA for X ray radiation qualities used in general diagnostic radiology and mammography were performed in Q3/2012 (EURAMET. RI(I)-S10, draft B in progress).

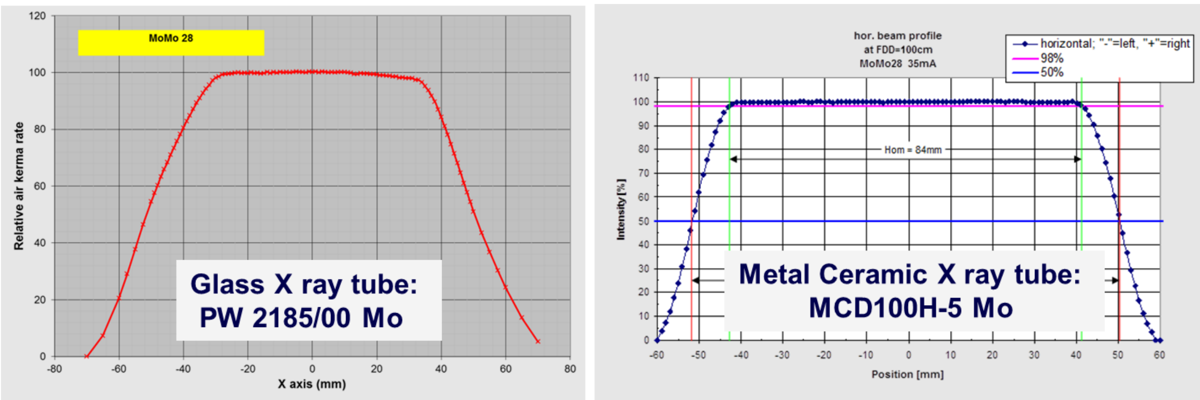

Fig.4: Comparison of horizontal beam profiles measured at SSD=100 cm (FS= ϕ 10 cm), HV=28 kV (I=35 mA), added filtration 0.033 mm Mo.

5.3.6 Comparison programme of ionization chamber calibration coefficients

A proficiency testing programme, initiated in 1995, verifies the ability of SSDLs to transfer a calibration from their standards to the user. The SSDL calibrates a transfer ionization chamber, sends it to the IAEA for calibration and repeats the calibration once the chamber has been returned to the

SSDL. The ratio of calibration coefficients determined by the SSDL and the IAEA is used as a criterion to judge the metrological quality of the calibration performed by the SSDL.

During 2011-2012, 22 SSDLs participated in the therapy level comparison programme for ionization chamber calibration coefficients in a ^{60}Co gamma ray beam. Calibrations both in terms of air kerma and absorbed dose to water were included. The ratio of calibration coefficients was corrected for any difference between the standard at the PSDL used by the SSDL and the corresponding standard of the IAEA. The particular IAEA standards are traceable to BIPM so the values of $k_{PSDL/BIPM}$ published in the BIPM key comparison database were used for this purpose. Assuming a typical relative standard uncertainty for air kerma and absorbed dose to water calibration of an ion chamber at SSDLs of about 0.75% (at k=2) as recommended in IAEA TRS 374, the IAEA has set an acceptance limit of 1.5%. No discrepancies outside the 1.5% acceptance limit were identified (see Figure 5).

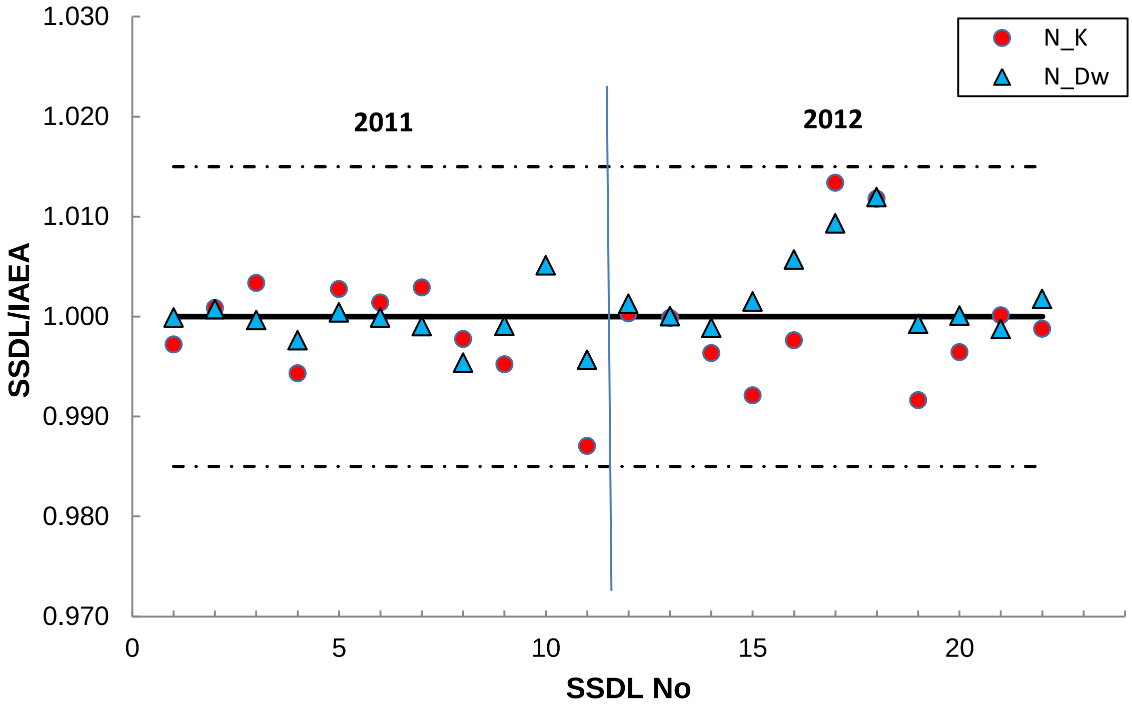

FIG.5: Results of comparison of radiotherapy chamber calibrations in 2011-2012. Circles correspond to air kerma calibration coefficients and triangles to absorbed dose to water factors. Results are considered acceptable if the deviation of the ratio from unity is less than 1.5%.

5.3.7 TLD-based monitoring of SSDL measurements

Radiation therapy level

The IAEA/WHO TLD postal dose quality audit service has monitored the performance of SSDLs in the therapy dose range since 1981. Results of this programme indicate that approximately 98% of 58 SSDLs that participated in the TLD audits in 2011-2012 biennium have results within the 3.5% acceptance limit.

The results for dose delivery under reference conditions in a water phantom for the laboratories providing therapy level calibrations are presented in Figure 6, where deviations from the IAEA's TLD results are plotted for ^{60}Co and high energy X rays. During the review period, two SSDL TLD runs (2011 and 2012) were completed, in which 104 beams were checked (82 ^{60}Co and 22 high energy X ray beams from medical accelerators).

For laboratories with deviations outside the acceptance limit, a follow-up programme has been established to resolve the discrepancies. Those laboratories are informed by the IAEA about the discrepancy, and assisted to understand and resolve the problem. A second (follow-up) TLD set is sent to each of these SSDLs and deviations outside the 3.5% limit are explained and corrected.

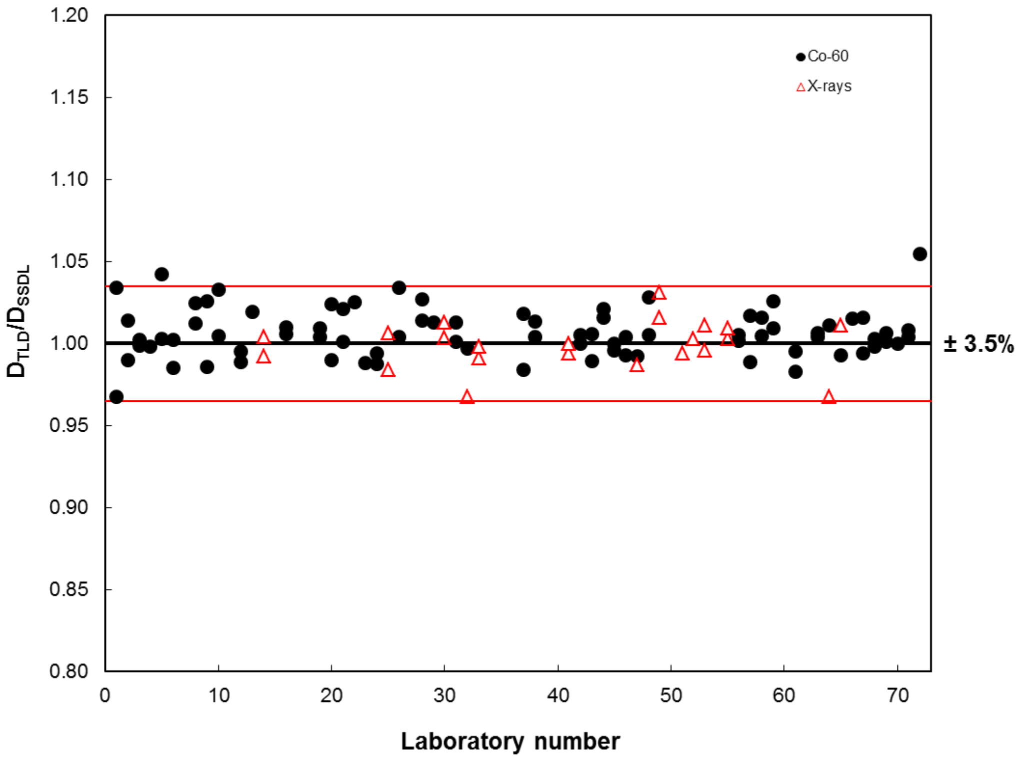

FIG. 6: Results of the IAEA/WHO TLD postal dose audits for SSDLs for the delivery of dose to water under reference conditions for the 2011 and 2012 TLD runs. Data in the graph correspond to the ratio of the IAEA's determined dose from the TLD-response (D_{TLD}) to that stated by the SSDL (D_{SSDL}). Each data point corresponds to the average of three dosimeters. A total of 104 beam calibrations was checked and included 82 ^{60}Co (circles) and 22 high energy X ray beams (triangles). The number of therapy beams checked in different TLD runs was: 49 beams in 2011 and 55 beams in 2012. Two deviations were found outside the acceptance limit of 3.5% in 2011 TLD run that have been followed-up.

Radiation protection level

The IAEA has also developed a (TLD service checking ^{137}Cs beam calibrations at the radiation protection level by the SSDLs. The laboratories are supplied with TLDs and asked to irradiate them at 5 mGy air kerma. The dosimeters are evaluated by the IAEA. The SSDLs with results outside the acceptance limit of 7% are contacted and support is provided to resolve the discrepancies. As a routine, they are invited to participate again in the next TLD audit run.

One TLD run was organized in 2011 and another one in 2012. Forty six SSDLs participated in these runs. The 2012 TLD run is currently being evaluated. Figure 7 shows the results of 2005-2011 run. These results show that most SSDLs are capable of measuring air kerma for radiation protection calibration purposes within the 7% acceptance limit. During 2011-2012 runs, BEV, MKEH and PTB irradiated dosimeters for quality control purposes. These dosimeters are used as an independent check of the IAEA TLD measurement system used for this service.

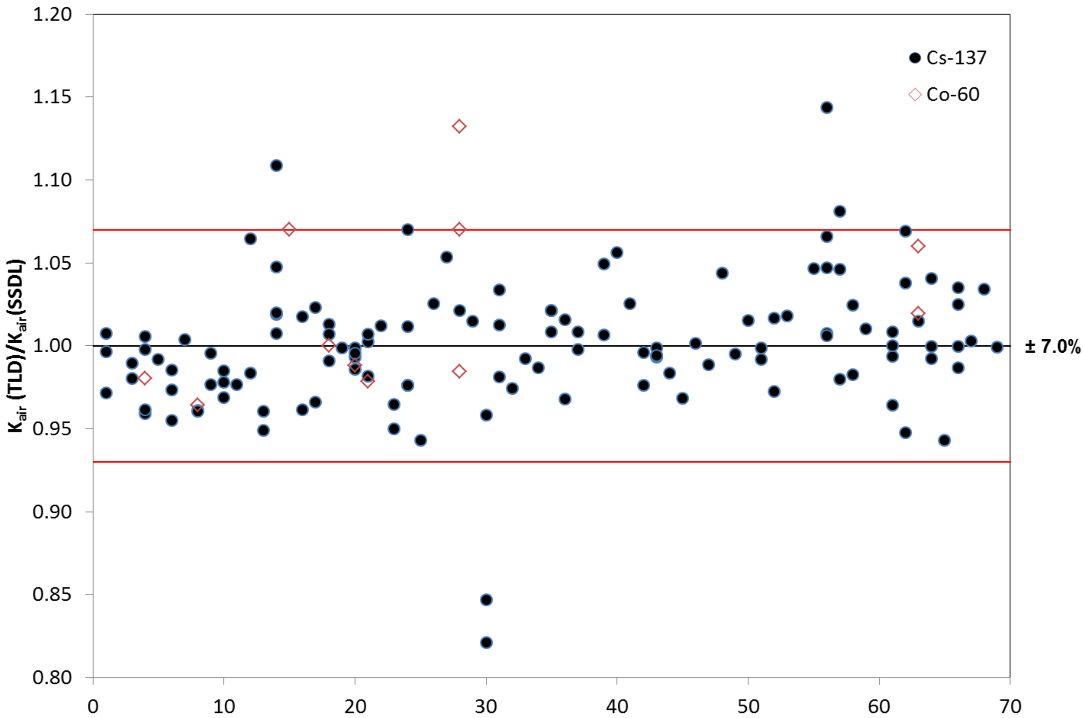

FIG.7: Results of the IAEA/WHO TLD postal dose audits for SSDLs of the air kerma stated by SSDLs to the TLD measured value at the Agency's Dosimetry Laboratory at radiation protection level during 2005–2011. Each data point corresponds to the average of three dosimeters.

6. QUALITY AUDITS IN RADIOTHERAPY DOSIMETRY (PROJECT 2.2.4.1)

6.1 THE IAEA/WHO TLD POSTAL SERVICE

In 2011–2012, the IAEA/WHO TLD postal dose audit service for hospitals continued its previous developments by improving the organization of the service. At present the number of hospital beams monitored is approximately 600–700 per year.

During this review period, the TLD programme provided over 1300 TLD sets to hospitals; of these, by March 2013, the results were available for 1098 beams in 622 radiotherapy centres in 92 countries with the reminder of TLDs being on the way to the IAEA for evaluation. The global results are shown in Figure 8. Approximately 92% of the results were found within the acceptance limit of 5%. All results outside the acceptance limit were followed-up in order to resolve discrepancies and correct errors in hospital dosimetry.

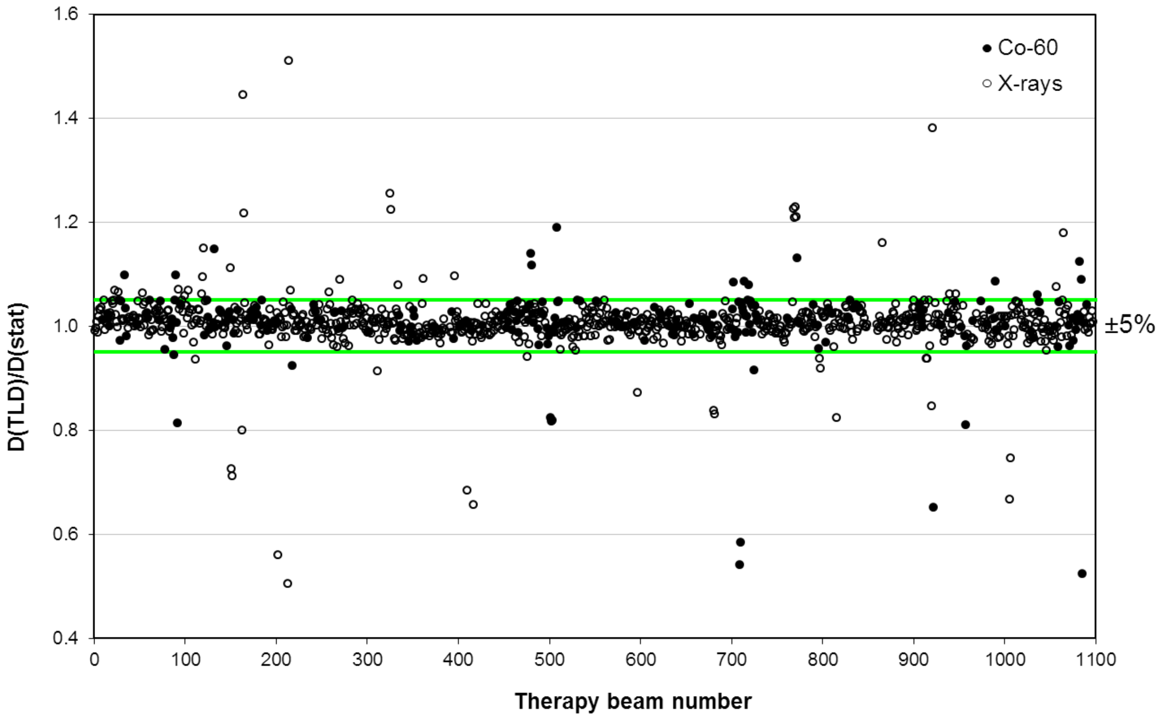

FIG. 8: Results of the IAEA/WHO TLD postal dose audits of radiotherapy hospitals for the delivery of absorbed dose to water under the reference conditions for TLD batches B221 to B240 (from January 2011 to December 2012). Data in the graph correspond to ratios of the IAEA's determined dose (DTLD) relative to the dose stated by the hospital (Dstat). Each data point corresponds to the average of two dosimeters. A total of 1098 beam calibrations were checked, which included 282 60Co (black dots) and 816 high energy X ray beams (open circles). Approximately 8% of the results were found outside the 5% acceptance limit. Of these, 4% were corrected by March 2013 due to subsequent follow-up action or by expert visits.

Thanks to the follow-up action, the percentage of acceptable results increased from 92% to 96% in 2011–2012, leaving approximately 4% of the results that have not been corrected. Of these 4%, 3% of the cases pertain to on-going follow-up action (not completed by March 2013) with the follow-up TLDs that are still expected to be returned from hospitals. The remaining 1% of the deviations persists due to local problems that could not be resolved without the allocation of additional resources.

The percentage of acceptable results for ^{60}Co beams is relatively low, 88% at the first check and 94% after follow-up, compared to 93% acceptable results (97% after the follow-up) for high energy X ray beams. Many ^{60}Co units are obsolete machines awaiting replacement. They are often operated without properly qualified medical physicists. Occasionally, the physics support exists, but reliable dosimetry systems are not available.

As the number of radiotherapy facilities in the world continues to increase, in 2011–2012, 146 additional radiotherapy centres joined the TLD audit network. Approximately 89% of the beam checks in hospitals that received TLDs for the first time showed acceptable results compared to 95% of acceptable results for institutions that benefited from a previous TLD audit. In a few countries, where structural inadequacies exist and medical physics training is deficient, recurrent deviations in TLD results are observed that cannot be resolved in a sustainable manner without the strong local commitment.

To provide appropriate QA for the TLD system, in addition to contacts with BIPM and PSDLs, systematic collaborations with other TLD-based QA networks are maintained.

In order to support sustainability, the IAEA assists Member States to establish national TLD programmes and whenever possible, establishes links between these national programmes and the IAEA's Dosimetry Laboratory. A Coordinated Research Project (CRP E2.40.16) "Development of a TLD based quality audits for complex treatment techniques", dealing with TLD audits of irregular MLC shaped fields and checking how treatment planning systems deal with the presence of heterogeneities was completed in 2012.

6.2 QUALITY ASSURANCE TEAM FOR RADIATION ONCOLOGY (QUATRO)

A comprehensive clinical audit methodology is described by the IAEA publication "Comprehensive Audits of Radiotherapy Practices: A Tool for Quality Improvement". The IAEA audit methodology, also known as Quality Assurance Team for Radiation Oncology (QUATRO) methodology, puts emphasis on radiotherapy structure and process. It includes assessment of infrastructure as well as of patient-related and equipment-related procedures involving radiation safety and patient protection aspects, where appropriate. Staffing levels and professional training programmes for radiation oncologists, medical radiation physicists and radiation therapists are also reviewed.

QUATRO has conducted approx. 70 audits on request, in radiotherapy centres from Central and Eastern Europe, Asia, Africa, and Latin America.

QUATRO audits aim to help radiotherapy centres attain the best level of practice possible for their country. Auditors identify gaps in technology, human resources and procedures, allowing the audited centres to document areas for improvement. Some centres have been acknowledged for operating at a high level of competence, while others have received recommendations. Overall, the audits have contributed to significant improvements at radiotherapy centres, and to identifying common issues of concern to address internationally. An example of this is the training of radiation therapists in Central and Eastern Europe, now being implemented through the IAEA's cooperation with the European Society for Therapeutic Radiology and Oncology (ESTRO).

7. QUALITY ASSURANCE AND GUIDELINES FOR MEDICAL PHYSICS IN THE OPTIMIZATION OF CLINICAL RADIATION IMAGING (PROJECT 2.2.4.3)

This project is focused on imaging sciences including both diagnostic radiology and nuclear medicine. It provides advice to Member States, who increasingly require the use of advanced medical radiation imaging services in areas such as Computed Tomography, Positron Emission Tomography and tele-radiology, as well as basic level services. The overall aim of this project is to strengthen QA processes, through the development and establishment of harmonized standards and guidelines, promotion of research and development in clinical dosimetry and image quality, and the promotion of the education of clinical medical physicists through both academic and clinically based instruction.

7.1 DEVELOPING METHODOLOGIES AND GUIDELINES

This activity embodies the strengthening of QA processes in diagnostic radiology and nuclear medicine, through the development and establishment of harmonized standards and guidelines, in conjunction with appropriate professional and international organizations. The major activities of this project, as described in the following paragraphs, are related to publications in the field.

7.1.1 Guidelines for Member Staets to adopt modern technology for radiology services (in collaboration with WHO)

Towards worldwide implementation of digital imaging in radiology – WIDIR

This publication is intended to cover issues associated with the introduction of information technology (IT) in radiology. In response to the need for advice in this area to Member States, and as a result of a request from WHO made through the Scientific Committee of the IAEA/WHO Network of SSDLs in 2006, work was begun to investigate this topic.

The publication is aimed at administrative, clinical and technical staff who are faced with the introduction of digital technology in the practice of diagnostic radiology in their clinics. It should also be of interest to government and other funding agencies, including philantropic and Non-Governmental Organizations. It provides a basic introduction in digital technology and digital networks as well as a good overview of the issues to consider when implementing such technology in diagnostic radiology. It has an extensive reference and bibliography.

The publication is nearing completion and is at the stage of its final review.

7.1.2 Clinical paediatric doses in diagnostric radiology

Dosimetry in Diagnostic Radiology for Paediatric Patients

Concern about the radiation dose to children from diagnostic radiology examinations has recently been popularly expressed, particularly as related to computed tomographic (CT) procedures, but also extended to a broad range of paediatric diagnostic radiological procedures responsible for child radiation dose.

In response to this, a need to inform health professionals on standardized methodologies to determine paediatric dose was identified, for all major modalities such as general radiography, fluoroscopy and CT.

Following the recommendations of the SSDL Scientific Committee, development of this publication, as a complement to TRS No. 457, was started in 2010 with the appointment of a drafting group. The publication is now finalized and is in the final editing stage, before publication.

7.1.3 Dosimetry Code of Practice for radiation measurements in diagnostic radiology

Following the publication of the Technical Report Series No. 457 ("Dosimetry in Diagnostic Radiology: An International Code of Practice"), two CRPs were initiated in order to address the implementation aspects of this CoP. The first CRP has been completed and has resulted in a corresponding publication, while a second one is in progress (Appendix I, E2.10.08).

Human Health Reports 4, Implementation of the International Code of Practice on Dosimetry in Diagnostic Radiology (TRS 457): Review of Test Results (2011)

The implementation of TRS No. 457 decreases the uncertainty in the dosimetry of diagnostic radiology beams and provides Member States with a unified and consistent framework for dosimetry in diagnostic radiology.. A CRP E2.10.06 was established in order to provide practical guidance to professionals at SSDLs and to clinical medical physicists on the implementation of TRS No. 457. This includes the calibration of radiological dosimetry instrumentation, the dissemination of calibration coefficients to clinical centres and the establishment of dosimetric measurement processes in clinical settings. The resulting publication is a compilation of the results, findings and recommendations of the participants of the CRP. It seeks to illuminate and highlight any issues that have arisen during the CRP period and thus supplements the work of TRS No. 457. New material in the areas of kerma area product (KAP) meter calibration and discussions on beam qualities appropriate for KAP meter and mammography measurements are presented. The results of diagnostic dosimetry implementation tests, along with recommendations for use of the code of practice, are discussed, including examples of computed tomography dose calculations and of the estimation of uncertainty.

7.1.4 Guidelines for QA/QC procedures in diagnostric radiology

The IAEA has been very active in promoting the use of nuclear medicine technology around the world, especially in developing countries, as an effective way of treating cancer. These efforts have been so successful that there are only a small number of countries worldwide that do not have at least some degree of nuclear medicine practice. As countries adopt these techniques, it is necessary for them to have a uniform, effective quality assurance (QA) programme that can ensure the quality of all nuclear medicine practices. The following publications were produced to assist Member States in the field of Quality Assurance and dosimetry in diagnostic radiology.

Human Health Series No. 17, Quality Assurance Programme for Digital Mammography (2011)

Currently there is a small number of QA protocols in digital mammography that apply to limited national and regional settings. Many Member States, therefore, have requested guidance in this area. In responding to these requests, the current publication was written with the aim of presenting an internationally harmonized approach to QA in the field. This approach will allow Member States to implement QA of mammography in a standardized way.

This publication was developed as a companion to the IAEA Human Health Series No. 2 ("Quality Assurance Programme for Screen Film Mammography") and follows the same format and style. The IAEA has convened three consultants meetings to prepare the publication. Additional work includes the field testing of a number of new phantoms and test equipment developed for the digital environment, and the compilation of performance standards. This work is ongoing and is accessible on the IAEA web site (http:\\humanhealth.iaea.org)

Human Health Reports 5, Status of Computed Tomography Dosimetry for Wide Cone Beam Scanners (2011)

This publication reviews the development of current CT dose formalisms up to the current International Electrotechnical Commission (IEC) methodologies and presents practical measurement guidance in the implementation of new dosimetric methods needed with wide beam CT. Additional items of discussions are current approaches of the American Association of Physicists in Medicine in USA to CT dosimetry as well as calibration aspects of CT dosimetric instrumentation.

Human Health Series No. 19, Quality Assurance Programme for Computed Tomography: Diagnostic and Therapy Applications (2012)

The role of CT in modern medicine is well established as a means of diagnosis and also as an essential precursor to radiation therapy treatment. The Human Health Series No. 19contains advice applicable to both diagnostic and therapeutic applications of CT, in recognition of the fact that in many facilities the use of a CT scanner for both diagnostic and therapeutic applications may be common. Currently, there are a small number of QA protocols in CT that apply to limited national and regional settings. Many Member States, therefore, have requested guidance in this area. In responding to these requests, the current publication was written with the aim of presenting an internationally harmonized approach to QA in the field. This approach will allow Member States to implement QA in CT in a standardized way.

7.1.5 QA/QC in nuclear medicine equipment and procedures

PET/CT Atlas on Quality Control and Image Artefacts

This document provides guidance on typical image distortions in clinical PET/CT usage scenarios. A number of cases are presented to provide nuclear medicine and radiology professionals with an assortment of examples of possible image distortions and errors in order to support a correct image interpretation. About 70 typical PET and PET/CT cases, comprised of image sets and cases, have been collected in this volume, all catalogued and provided with explanations as to the causes of and solutions to each individual image problem. This atlas is intended to be used as a guide on how to take proper quality control measures, on performing situation and problem analysis, and on problem prevention.

The PET/CT Atlas, which is finalized, has been produced with the support of experts and consultants who have contributed through Technical Co-operation projects and research and technical contracts. It is hoped that it will be especially useful to medical physicists, physicians, technologists and service engineers in the clinical field.

7.1.6 Quantitative nuclear medicine and internal dosimetry

The absolute quantification of radionuclide distribution has been a goal since the early days of nuclear medicine. Nevertheless, the apparent complexity and sometimes limited accuracy of quantification methods have prevented them from being widely used in important applications, such as targeted radionuclide therapy or kinetic analysis. The aim of this activity is to promote and harmonize quantitative nuclear medicine applications through a publication and the implementation of a CRP ((Appendix I, E2.10.07)

Quantitative Nuclear Medicine Imaging: Concepts, Requirements and Methods

The purpose of this publication is to review the current state of the art of image quantification, and to provide a solid background of tools and methods to medical physicists and other related professionals who are facing this task. It describes and analyses the physical effects that degrade image quality and affect the accuracy of quantification and describes methods to compensate for them in planar, SPECT and PET images.

This publication complements previous efforts of IAEA related to activity measurement and quantification, such as TRS 454. The publication has been finalized and is awaiting publication.

7.2 PROMOTION OF CLINICAL AUDITS

One of the key parameters in the development of a sustainable environment of quality practice in diagnostic radiology is the establishment of clinical audits. Clinical audits involve the evaluation of data, documents and resources to check the quality of diagnostic radiology services against well-established standards. This activity provides both independent external audit services to Member States and education and training to allow Member States to create their own teams of auditors. The basic principles and methodologies related to clinical audits in diagnostic radiology have been published in the form of a comprehensive document.

Human Health Series 4, Comprehensive Clinical Audits of Diagnostic Radiology Practices: A Tool for Quality Improvement Quality Assurance Audit for Diagnostic Radiology Improvement and Learning (QUAADRIL)

The published guidelines for "Comprehensive Clinical Audits of Diagnostic Radiology Practices" have increased awareness in Member States in such activities and requests have been submitted both for clinical audits and for training of future auditors. In order to further promote the importance of clinical quality audits, the document has been translated into Spanish and published in 2011.

The accumulated experience in the auditing procedures through the first audits implemented, have raised the need of reviewing the content of the QUAADRIL document. This review process has been planned for 2013.

7.3 EDUCATION AND TRAINING

An important component of the activities of the project is related to the promotion of the academic education and clinical training of medical physicists. These activities involve the development of training material in the form of comprehensive handbooks for diagnostic radiology and nuclear medicine, which can be utilized as resources for medical physicists initiating their studies.

The educational component of the project also contains more direct training activities, such as the implementation of training courses and the support of the postgraduate training of medical physicist, through a recently approved doctoral CRP.

7.3.1 Development of comprehensive educational material

Diagnostic Radiology Physics: A Handbook for Teachers and Students

This handbook aims at providing the basis for the education of medical physicists initiating their university studies in the field of diagnostic radiology. This has been achieved with the work of 40 authors and reviewers from 12 different countries. The 24 chapters include a broad coverage of topics relevant to diagnostic radiology physics, including the radiation physics, dosimetry and instrumentation, image quality and image perception, imaging modality specific topics, recent advances in digital techniques and radiation biology and protection. Endorsement of this book has been granted by the European Federation of Organisations for Medical Physics (EFOMP), the Asian Federation of Organisations for Medical Physics (AFOMP), and the American Association of Physicists in Medicine (AAPM).

In addition to Handbook, in order to promote its educational role, the IAEA has developed teaching slides for each chapter of the book, to make them accessible from the IAEA website.

The Handbook is nearing completion as it is in the final editorial process before publication.

Nuclear Medicine Physics: A Handbook for Teachers and Students

This handbook, including 20 chapters, comprehensively covers the physics of nuclear medicine. It is intended for undergraduate and post-graduate students in medical physics. It will also serve as a resource for the interested reader from other disciplines such as clinicians, radiochemists and medical technologists wanting to familiarize themselves with the basic concepts and practice of nuclear medicine physics.

Endorsement of this handbook has been granted by the American Association of Physicists in Medicine (AAPM), the Australasian College of Physical Scientists and Engineers in Medicine

(ACPSEM), the Asia–Oceania Federation of Organizations for Medical Physics (AFOMP), the European Federation of Organizations for Medical Physics (EFOMP), the Federation of African Medical Physics Organizations (FAMPO), and the World Federation of Nuclear Medicine and Biology (WFNMB).

The Handbook is also nearing completion as it is in the final editorial process before publication.

7.3.2 Training Courses

Joint ICTP-IAEA School

In 2011, a Joint ICTP-IAEA Advanced Course on Mammography was held from 3-7 October 2011 at the International Centre for Theoretical Physics (ICTP) in Trieste, Italy. This event was attended by 31 participants from all regions, medical physicists with responsibilities in diagnostic radiology, and teachers involved in medical physics education programmes.

Gamma-camera Laboratory

The Gamma-camera Laboratory in Seibersdorf is equipped with instrumentation that make it suitable for training of medical physics in muclear medicine. The lab now hosts two gamma-cameras, anthropomorphic and geometrical phantoms, calibration and flood sources, micro-pipettes, analytical scale, dose calibrator, and a NaI gamma-well counter. During the reporting period, training courses for medical physicists on the acceptance testing of a gamma camera have been held in the facility. Such a training facility is particularly valuable, since very few clinics would allow the extra time required on their cameras for training purposes.

7.3.3 Doctoral CRP on the advances in medical imaging techniques

The main concept of a doctoral CRP is to match scientists from developing and developed countries, to conduct research on topics associated with modern medical imaging, both in diagnostic radiology and nuclear medicine. Through this coupling of scientists, the capabilities of participating countries to be involved into state of the art scientific research will be enhanced, while scientific networks will be created between Member States.

The scientific content and the requirements for participation in the CRP have been discussed in a Consultant Meeting in 2012. The experts strongly endorsed the proposal and prepared a set of guidelines for selecting participants; the PhD student, the local supervisor (contract holder) and the remote mentor (agreement holder).

The CRP was approved in 2012 for initiation in 2013.

7.3.4 Clinical training guidelines for medical physicists in diagnostric radiology and nuclear medicine

In order to promote and harmonize the clinical training of medical physicists, the IAEA has published Training Course Series for training programmes specializing in diagnostic radiology and nuclear medicine.

In order to promote and harmonize the clinical training of medical physicists, the IAEA has published Training Course Series for training programmes specializing in diagnostic radiology and nuclear medicine.

Training Course Series 47, Clinical Training of Medical Physicists Specializing in Diagnostic Radiology (2011, 2012)

Development of the clinical training guide for medical physicists specializing in diagnostic radiology started in 2007 with the appointment of a drafting committee of regional and international experts and was completed in 2011 with its publication as Training Course Series 47 (TCS-47). The need to further expand the target audience of this training guide resulted in its translation to French and Spanish, published in 2012.

Training Course Series 50, Clinical Training of Medical Physicists Specializing in Nuclear Medicine (2011, 2012)

Accompanying to the TCS-47, a clinical training guide for medical physicists specializing in nuclear medicine was completed in 2011 with its publication. The guide was translated to French and published in 2012.

8. QUALITY ASSURANCE AND MEDICAL PHYSICS DEVELOPMENTS IN RADIOTHERAPY AND THERAPEUTIC NUCLEAR MEDICINE (PROJECT 2.2.4.4)

The objective of this project is to contribute to new developments, worldwide harmonization and implementation of quality assurance procedures in radiation oncology.

The objectives of this project were primarily achieved through conducting CRPs, convening conferences and consultants' meetings, developing guidelines, publishing research results, maintaining computer databases, developing and implementing training courses in QA, and disseminating information through electronic media. Improvements in the physical and technical aspects of quality assurance in radiotherapy in Member States are sought by encouraging the adoption and use of Agency guidelines and recommendations. Through these developments, the project contributes to the creation of a quality assurance culture in all aspects of radiotherapy measurements and patient dosimetry, which, as a parallel effect, will improve radiation safety and effectiveness in hospitals in developing Member States. Collaboration with professional societies such as IOMP (Internatuonal Organization for Medical Physics), ESTRO (European Society for Therapeutic Radiology and Oncology), AAPM (American Association of Physicists in Medicine) and European Federation of Organizations for Medical Physics (EFOMP) is important in order to jointly contribute to developments in the area of dosimetry and quality assurance, to harmonize procedures and to benefit from early access to on-going projects. Specific achievements in this project are included in the following sections.

8.1 SMALL FIELD DOSIMETRY

An international working group was formed, in collaboration with the AAPM, with the aim of publishing an extension of existing Codes of Practice to provide recommendations on reference conditions and reference dosimetry procedures for small and composite fields. A first step in this direction was the publication of a proposed formalism in a peer-reviewed journal allowing for such an extension. The aim of the publication was to get the ideas of extended reference conditions out and to invite medical physicists and scientists worldwide to contribute to improved knowledge and understanding in this area by discussion and research. The working group met several times and discussed the topic through conference calls. The group is finalizing a draft IAEA publication that focuses on the dosimetry of small static fields. The next step will be the publication of a Code of Practice for small field dosimetry.

8.2 DEVELOPMENT OF GUIDELINES FOR QA OF RECORDS AND VERIFY SYSTEMS

In reviewing the available documentation on this topic, it was recognized that there is very little information published on the quality assurance of record and verify systems, including guidelines for acceptance testing and commissioning. To this end a Human Health Report on Record and Verify Systems for Radiation Treatment of Cancer: Acceptance Testing, Commissioning and Quality Control has been prepared and will be published in 2013.

8.3 DEVELOPMENT OF GUIDELINES ON ACCURACY REQUIREMENTS AND UNCERTAINTIES IN RADIATION ONCOLOGY

While a number of reports and publications have defined accuracy needs in radiation oncology, most of these reports were developed in an era with different radiation technologies. In the meantime, there have also been improvements in dosimetry standards. Furthermore, the published accuracy requirements were partially based on clinical information and clinical procedures available at that time, prior to the days of image-based 3-D CRT or IMRT. In addition to technological changes and advances in dosimetry, significant data have been published on clinical studies using these new technologies. In view of the new technologies and techniques, improvements in dosimetry methodologies and new clinical dose volume data, the IAEA has prepared a new international guidance document on accuracy requirements and uncertainties in radiation therapy. The publication includes clinical, radiobiological, physical and technical aspects as applied to the entire process of radiotherapy. In addition, recommendations on the determination and management of uncertainty are provided. In addition, a consultants meeting held in 2012 recommended that the IAEA initiate a co-ordinated research project to investigate the relationship between the extent and depth of the quality assurance programme to the accuracy achievable in independent end-to-end phantom tests. This was approved in 2012 (E2.40.17).

8.4 STAFFING REQUIREMENTS IN RADIATION ONCOLOGY

The IAEA previously defined the staffing levels required to support the establishment of a basic radiotherapy service. With the recent advances in technology, techniques and hybrid modalities, a new approach is required to support Member States maintain adequate staffing in order to ensure safe and effective practice. A technical meeting was held in 2011 to consider the publication of an IAEA guidance document on staffing levels for all categories of professional staff supporting radiation medicine. Two further consultants meetings were held to refine the activity-based staffing model that was developed. A publication on ‘Staffing Requirements in Radiation Medicine’ was drafted, which includes spreadsheets to predict staffing levels based on time, the number of patients and the number of procedures. The model was subsequently tested in Member States for a range of technologies and techniques. The consensus document will be submitted for publication in 2013.

8.5 RESOURCE-ADAPTED POLICIES AND TECHNIQUES FOR CANCER TREATMENT

Several IAEA publications exist which assist Member States establish or expand radiotherapy services, however none addresses the technical details of the design and construction. In order to assist Member States master-plan a successful project, a complementary publication on the ‘Design and Construction of Radiotherapy Facilities’ was drafted in conjunction with clinical, architectural, engineering and medical physics consultant expertise and this will be submitted for publication in 2013.

8.6 EDUCATION AND TRAINING

8.6.1 Training material for the transitioning from 2D to 3D conformal radiotherapy (CRT) and intensity modulated radiotherapy (IMRT)

The appropriate transition from 2D radiotherapy to more sophisticated techniques remains a challenge in many Member States often owing to unrealistic expectations from advanced technologies. A complete set of slides were developed by clinical, medical physics and radiation therapy expertise, based on the transition process defined in the IAEA-TECDOC-1588 document. The material provides Member States with a comprehensive set of training material to support the transition to 3D CRT and IMRT, and is a necessary resource to ensure that IAEA regional training courses are harmonized. The training material CD is aimed at all categories of staff that are affected by the process and also includes a list of other references and material available. The material was edited and reviewed in 2012 and is due for publication in 2013.

8.6.2 Post-graduate medical physics academic programmes

The IAEA has published a number of documents in support of the recognition of clinical medical physicists. These have included, amongst others, recommendations on the roles and responsibilities of clinically qualified medical physicists working in therapeutic and diagnostic radiation medicine, who have undergone appropriate post-graduate academic education and hospital-based clinical training. The IAEA has published three Training Course Series publications with accompanying handbooks, which provide guidelines and references to training material for clinical training programmes for medical physicists specializing in radiation oncology, diagnostic radiology and nuclear medicine, respectively. Prior to embarking on a clinical training programme, the resident medical physicist requires appropriate post-graduate academic education to provide the background knowledge to support the acquisition of skills and competencies implicit in a hospital-based clinical residency.

There is a worldwide shortage of clinical medical physics professionals and medical physics academics. The safe and effective implementation of technology in radiation medicine requires expert medical physics oversight and support. There are very few established, accredited academic education programmes for medical physics students and no international guidelines exist, which provide the recommended requirements, outline and structure of such a programme. An increasing number of Member States with a critical mass of medical physicists are seeking support to initiate their own national programmes. A consultants meeting was convened in 2012 in order to draft IAEA guidelines for setting up a post-graduate academic education programme in medical physics. This is being done in collaboration with the IOMP.

8.6.3 Transitioning from 2D to 3D high dose rate brachytherapy

Recently there have been an increasing number of international guidelines and recommendations in support of 3D image-based brachytherapy. A consultants meeting was held in 2012 in order to consider the development of an IAEA guidance document, including a self-assessment tool to support implementation of Technical Co-operation projects in this field. A document was drafted and it was recommended that training material also be developed in support of this process, as per 8.6.1.

8.6.4 Joint ICTP-IAEA School

In 2011, a Joint ICTP-IAEA School on Advanced Radiotherapy Techniques with Emphasis on Imaging and Treatment Planning was held from 4-8 April at the International Centre for Theoretical Physics (ICTP) in Trieste, Italy. This event was attended by 20 participants from all regions,

In 2012, a Joint ICTP-IAEA International Training Workshop on Transitioning from 2D to 3D Conformal Radiotherapy and Intensity Modulated Radiation Therapy at the International Centre for Theoretical Physics (ICTP) in Trieste, Italy. It was attended by 20 clinical radiotherapy medical physicists from all regions.

9. DIRECTORY OF RADIOTHERAPY CENTRES (DIRAC)

Since 1959, the IAEA has maintained a register of radiotherapy hospitals and clinical institutions having radionuclide and high-energy teletherapy machines. This was initially available in printed form only, last published in 1968. The present electronic version of the Directory of Radiotherapy Centres (DIRAC) includes data on teletherapy machines, sources and devices used in brachytherapy, and on equipment for dosimetry, treatment planning systems and quality assurance. Staff strength at the installations (radiation oncologists, medical physicists, technicians, etc.) is included as well.

The present electronic version of DIRAC is equipped with an on-line web interface (http://www-naweb.iaea.org/nahu/dirac/). The remote users are given active access to DIRAC that enables any necessary modifications and updates of the information regarding their radiotherapy centres. Thus the DIRAC database is being continuously updated, based on on-line completion of the electronic questionnaires by radiotherapy centres. At the same time other sources of information are used and data obtained from the existing national registries are compiled.

At present DIRAC is the only centralized database that describes the capacity for delivery of radiation therapy worldwide. It encompasses approximately 90% of the existing radiotherapy facilities and constitutes an important source of information for the analysis of provision of radiation therapy in the world and for estimating the needs for radiotherapy facilities in the various regions or countries.

Appendix 1

Coordinated Research Projects

Table 1 provides a compilation of the CRPs within the sub-programme that were operational during the reporting period.

TABLE 1. Coordinated Research Projects (CRPs) in dosimetry, operational in 2011-2012

Year of commencement	CRP code and title	Year of completion	Participating institutions
2008	**E2.40.15:** Doctoral CRP on Quality Assurance of the Physical Aspects of Advanced Technology in Radiotherapy	2013	9
2009	**E2.40.16:** Development of Quality Audits for Radiotherapy Dosimetry for Complex Treatment Techniques	2012	6
2009	**E2.10.07:** CRP on the Development of Quantitative Nuclear Medicine Imaging for Patient Specific Dosimetry	2013	10
2010	**E2.10.08:** Development of Advanced Dosimetry Techniques for Diagnostic and Interventional Radiology	2013	13
2011	**E1.30.39** Enhancing Capacity for Early Detection and Diagnosis of Breast Cancer Through Imaging (with the Nuclear Medicine and Diagnostic Imaging Section)	2016	13

E2.40.15: Doctoral CRP on Quality Assurance of the Physical Aspects of Advanced Technology in Radiotherapy

The objective of this project is to enhance the capability of Member States to implement advanced radiotherapy treatments with curative intent, such as IMRT, stereotactic radiosurgery (SRS), image-guided radiotherapy (IGRT), by training a number of medical physicists at the Ph.D. level with research and clinical capability.

With the assistance of local and international supervisors, 6 medical physicists at the PhD level are producing research theses in one or more areas of advanced radiotherapy and will have the knowledge and capability to establish sustainable education and training programmes for the next generation of medical physicists at their centers thus increasing indigenous research activity in the Member States. In addition they will be able to assist their institutions to acquire the appropriate equipment and technology for the implementation of advanced radiotherapy treatments. The 3rd RCM was held from 12-16 November 2012.

E2.40.16: Development of Quality Audits for Radiotherapy Dosimetry for Complex Treatment Techniques

External audit is a crucial element in QA programmes for clinical dosimetry in radiotherapy. The CRP extends the scope of activities by national TLD-based networks from dosimetry audit for rectangular radiation fields to irregular and small fields relevant to modern radiotherapy.

The CRP's aim is to develop and make available a methodology and procedures for national External Audit Groups for dose measurement of complex radiotherapy parameters used for cancer treatment. This includes TLD based dosimetry for irregular MLC fields for conformal radiotherapy, for heterogeneous situations, and for small MLC shaped fields relevant to stereotactic radiotherapy and applicable to dosimetry for IMRT. In addition it includes a new development of film-based 2D dosimetry for testing dose distributions, specifically beam penumbra in small field geometry. The expected research outcome of this CRP is to assist Member States in developing national quality audit programmes for radiotherapy dosimetry and thus increase radiation dosimetry expertise internationally in order to potentially reduce the number of mis-administrations of dose to radiotherapy patients.

E2.10.07: CRP on the Development of Quantitative Nuclear Medicine Imaging for Patient Specific Dosimetry

The overall objective of this project is to assist Member States in accurately determining radionuclide distributions for diagnostic and therapeutic nuclear medicine.

Nuclear Medicine instruments have the potential to provide quantitative information and its distribution with time. This information provides the basis for internal dosimetry and is needed to properly optimize the use of any radiopharmaceutical. Patient specific dosimetry is often a legal obligation when administering radiopharmaceuticals for therapy. There are, however, no harmonized protocols or guidelines for acquiring quantitative information from Nuclear Medicine instruments. Nor are there documents that address the possibilities and limitations of these instruments for quantitative information. This CRP is expected to produce guidance documents that i) describe the methods required for quantification, including the definition of a standard set of physical and computer tools for ensuring consistent quantification in nuclear medicine; and ii) define what levels of reliability should be achievable with different levels of technology and for various tasks.

To date, two consultants meetings (2008 and 2010) and the first RCM (2009) have produced a draft guidance document "Quantitative nuclear medicine imaging: concepts, requirements and methods". An initial work plan has also been agreed upon. The first intercomparison involves Ba-133 phantoms, produced to primary standards quality at NIST, USA. The project will later involve Ge-68 (/Ga-68) phantoms for PET quantifications. Eventually these measurements will be collected, compiled, and summarized in an IAEA publication, along with discussions of the experiences of the different clinics. A Consultants Meeting and the 2nd RCM were held in parallel from 9-13 May 2011.

Areas of knowledge gaps in quantitative nuclear medicine will likely be identified. Centres will be given access to new guidance documents on how they can require the tools to evaluate the possible accuracy and precision for various quantitative tasks for different equipment. Ultimately, the diagnostic precision or therapeutic efficacy of nuclear medicine procedures is expected to improve.

E2.10.08: Development of Advanced Dosimetry Techniques for Diagnostic and Interventional Radiology

The objective of this CRP is to extend the Code of Practice for dosimetry in x-ray diagnostic radiology (TRS 457) in line with the recommendations from the previous CRP E2.10.06. It will focus on the extension of material in TRS 457 through a supplementary document to include detailed guidance of dosimetry in paediatric radiology, dose determination for the skin during clinical procedures, also the use of DICOM structures as a source of dosimetric data, and dosimetry for new imaging modalities, including advice on dosimetry for wide cone beam scanners. The status of organ dose determination for diagnostic radiology procedures, and the uncertainty involved in clinical and laboratory dose determination will be evaluated.

In the more specific area of calibration there is a focus on establishing the use of kerma length product and kerma area product calibration procedures as used for CT dosimetry instrumentation and for the use of KAP meters in fluoroscopy dosimetry, including the organisation of a comparison of KAP meter calibrations in conjunction with EUROMET.

The overall objective is to assist (i) secondary standard dosimetry laboratories in developing and providing appropriate calibrations of equipment and (ii) hospitals in conducting and interpreting dosimetry measurements for an extended range of x-ray modalities and patient profiles, in the Member States.

E1.30.39: Enhancing Capacity for Early Detection and Diagnosis of Breast Cancer through Imaging

The incidence and mortality from breast cancer is rising worldwide and particularly rapidly across the developing world, where most women with breast cancer seek medical attention at a late stage. There is limited expertise in quality breast diagnostic and screening services in most countries. X-ray mammography is the only test repeatedly proven to reduce the mortality rate for breast cancer, provided access to appropriate high quality imaging, treatment and care is available. This CRP improves women's health by developing the capabilities of centers to detect and diagnose early breast cancer through x-ray mammography, breast ultrasound and image-guided needle biopsy, thereby reducing breast cancer mortality and morbidity. It helps to assess the current practice of diagnosis and detection of breast cancer through imaging and then generation of standard operating procedure for breast cancer early diagnosis practice – in turn to identify suitable model for breast cancer detection and diagnosis in LMI countries.

Appendix 2

Training courses

The Dosimetry and Medical Radiation Physics Section placed considerable emphasis on organizing training courses and coordinating fellowships for medical radiation physicists and staff from SSDLs within the framework of IAEA Technical Cooperation projects.

The courses and workshops held during 2011–2012 were as follows:

2011

- RCA Training Course on Introduction to Image Based Radiotherapy, Quezon City, Philippines
- Regional Training Course on Medical Physics for Nuclear Medicine, Dubai, United Arab Emirates
- IAEA/RCA Training Course on Introduction to Image Based Radiotherapy, Jakarta, Indonesia
- Regional Training Course on Transitioning from 2D to 3D Conformal Radiotherapy, Córdoba, Argentina
- Regional Training Course on Medical Physics in Diagnostic Radiology, Bogotá, Colombia
- Regional Training Course on Quality Assurance in the Physical and Technical Aspects of Radiotherapy, Argonne, IL, USA
- Regional Training Course on Radiotherapy Techniques with Emphasis on Imaging and Treatment Planning, Riyadh, Saudi Arabia
- Regional Training course on Quality Assurance in Radiotherapy Physics of IMRT, São Paulo, Brazil
- Regional (ARCAL) Training Course on Nuclear Medicine Physics, Mendoza, Argentina
- ESTRO/IAEA Regional Training Course on Physics for Clinical Radiotherapy. Porto, Portugal
- Regional (AFRA) Training Course on Acceptance Test of Gama Cameras, Seibersdorf, Austria
- ESTRO/IAEA Course on Advanced Treatment Planning, Genova, Italy
- Regional Training Course on Dosimetry of Co-60 Beams and Quality Assurance in Radiotherapy, Kharkiv, Ukraine
- Joint ICTP/IAEA School on Advanced Radiotherapy Techniques with Emphasis on Imaging and Treatment Planning, Trieste, Italy
- Joint ICTP/IAEA Advanced Course on Mammography, Trieste, Italy
- Regional (AFRA) Training Course on Commissioning of LINACS, Abuja, Nigeria

- Regional (AFRA) Training Course on Uncertainty in Measurements Performed at SSDLs and Dosimetry Service Laboratories, Algiers, Algeria

2012

- National Training Course on QC of Radiotherapy Equipment, Kota Kinabalu, Malaysia
- ESTRO/IAEA Teaching Course on Bringing new RT Technology into the Clinic: An Evidence-based Approach (Russian edition), St. Petersburg, Russian Federation
- Regional Training Course on Commissioning and Quality Assurance for Radiotherapy Treatment Planning Systems, Novi Sad, Serbia
- ESTRO/IAEA/ Regional Training Course on Advanced Treatment Planning, Prague, Czech Republic
- ESTRO/IAEA Teaching Course on Modern Brachytherapy Techniques, London, UK
- Regional Training Course on Dosimetry and Quality Assurance of External Beam Radiotherapy, Moscow, Russian Federation
- IAEA/RCA Regional Training Course on Radiotherapy Techniques with Emphasis on Imaging and Treatment Planning, Beijing, China
- National Training Course: Master in Medical Physics, Lima, Peru
- National Training Course on QA/QC and dosimetry in radiotherapy-Sarajevo, Bosnia and Herzegovina
- Regional training Course on the Calibration of External Beam Radiotherapy Equipment, Doha, Qatar
- Regional Training Course on Medical Physics Aspects in Low and High Dose Rate Brachytherapy. Riyadh, Saudi Arabia
- Regional Training Course in hypofractionation and fractionated stereotactic radiotherapy : state of the art and future, Buenos Aires, Argentina
- Regional (AFRA) Training Course on Acceptance Test of Dual Head Gamma Cameras, Seibersdorf, AUS
- Regional (AFRA) Training Course on Frontline Servicing of a Best Equinox Cobalt Teletherapy Unit, Tunis, Tunisia
- Regional (AFRA) Training Course on Accidents and Audits in Radiotherapy and Peer Review (Initial Auditing) in Medical Physics, Argonne, USA
- Regional (AFRA) Training Course on Evidence-Based Brachytherapy, Harare, Zimbabwe
- Regional (AFRA) Training Course on Protection Level Calibrations Performed at Secondary Standard Dosimetry Laboratories, Alger, Algeria
- National Training Course on Quality Control and Dosimetry in Radiology, Tashkent, Uzbekistan

- ICTP/IAEA International Training Workshop on Transitioning from 2D to 3D Conformal Radiotherapy and Intensity Modulated Radiation Therapy, Trieste, Italy

Appendix 3

IAEA Publications in Dosimetry and Medical Radiation Physics

Below is the list of scientific and technical books published by the IAEA in 2011-2012. In addition to the book titles below, an IAEA SSDL Newsletter was published and distributed among the members of the SSDL Network and the scientific community. The Newsletter is also available on the Internet. A list of non-IAEA publications authored or co-authored by staff members of the DMRP Section during 2011–2012 is given in the Appendix 4.

2011

- Clinical Training of Medical Physicists Specializing in Diagnostic Radiology **(IAEA Training Course Series No. 47)**.
  http://www-pub.iaea.org/MTCD/Publications/PDF/TCS-47_web.pdf

- Clinical Training of Medical Physicists Specializing in Nuclear Medicine (Training Course Series No. 50).
  http://www-pub.iaea.org/MTCD/Publications/PDF/TCS-50_web.pdf

- Status of Computed Tomography Dosimetry for Wide Cone Beam Scanners (Human Health Reports No. 5)
  http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1528_web.pdf

- Implementation of the International Code of Practice on Dosimetry in Diagnostic Radiology (TRS 457) Review of Test Results (Human Health Reports No. 4)
  http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1498_web.pdf

- Quality Assurance Programme for Digital Mammography(Human Health Series No. 17)
  http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1482_web.pdf

- SSDL Newsletter No. 59. April 2011
  http://www-pub.iaea.org/MTCD/Publications/PDF/Newsletters/SSDL-NL-59.pdf

2012

- Clinical Training of Medical Physicists Specializing in Radiation Oncology (IAEA Training Course Series No. 37) SPANISH, FRENCH and RUSSIAN VERSIONS
  http://www-pub.iaea.org/MTCD/Publications/PDF/tcs37s_web.pdf
  http://www-pub.iaea.org/MTCD/Publications/PDF/TCS-37f_web.pdf
  http://www-pub.iaea.org/MTCD/Publications/PDF/TCS-37R_web.pdf

- Clinical Training of Medical Physicists Specializing in Diagnostic Radiology (IAEA Training Course Series No. 47). FRENCH VERSION
  http://www-pub.iaea.org/MTCD/Publications/PDF/TCS-47f_web.pdf

- Quality Assurance Programme for Computed Tomography: Diagnostic and Therapy Applications (Human Health Series No. 19).
  http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1557_web.pdf

- SSDL Newsletter No. 60. June 2012
  http://www-pub.iaea.org/books/IAEABooks/8945/SSDL-Newsletter-Issue-No-60-June-2012

Appendix 4

Non-IAEA publications authored or co-authored by staff members of the IAEA Dosimetry and Medical Radiation Physics (DMRP) Section, 2011-2012

2011

ABDEL-FWAHAB, M., **ROSENBLATT, E**., **HOLMBERG, O., MEGHZIFENE, A.**, Safety in radiation oncology: the role of international initiatives by the International Atomic Energy Agency. *Journal of the American College of Radiology, November 2011,* 8(11), *pp 789-94*

VAN DYK, J., **MEGHZIFENE, A**, Medical physics beyond borders: IAEA educational resources relevant to both the developed and developing world. *Med. Phys., volume 38, 2011 p 3829*

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