IAEA SUBPROGRAMME ON DOSIMETRY AND MEDICAL RADIATION PHYSICS (DMRP) REPORT ON ACTIVITIES, 2001–2002

K Shortt, A Meghzifene, J Izewska, F Pernicka, H Tölli, S Vatnitsky, P Bera, L Czap, R Girzikowsky

Dosimetry and Medical Radiation Physics Section, Division of Human Health, Department of Nuclear Sciences and Applications, International Atomic Energy Agency (IAEA), Vienna.

Introduction

The IAEA Subprogramme on Dosimetry and Medical Radiation Physics (DMRP) contributes to improving the quality of the IAEA's system to measure ionising radiation by disseminating traceable standards for radiation measurements, conducting dose quality audits and comparisons, developing and disseminating dosimetry techniques, assisting Member States in designing and implementing national Quality Assurance (QA) programmes, and organizing education programmes and training courses for medical physicists, radiation metrologists and other staff at hospitals and Secondary Standards Dosimetry Laboratories (SSDLs). In addition, technical support is provided to IAEA Technical Co-operation projects.

Projects in the DMRP Subprogramme

During the period 2001–2002 the Subprogramme was divided into four projects that have been reorganised now as follows:

- **Network of Secondary Standards Dosimetry Laboratories (SSDLs)** (IAEA Project F3.01)

  The objective of this project is to enhance the capability of Member States to achieve and maintain a high level of quality and consistency in radiation measurements and dosimetry standards, used in radiotherapy, diagnostic radiology, nuclear medicine and radiation protection, that are linked to the international measurement system in accordance with the Mutual Recognition Arrangement (MRA).

- **Quality assurance and dose audits to end-users** (IAEA Project F3.02)

  The objective of this project is to ensure the quality of the entire dosimetric chain in Member States through an independent means of verification of the dose to be delivered to the patients during radiotherapy (using mailed TLDs) and to the products irradiated by industrial processing facilities (using ESR measurements in alanine).

- **Research and development in radiation dosimetry techniques** (IAEA Project F3.03)

  The objective of this project is to strengthen capabilities and improve implementation of harmonized codes of practice in radiation dosimetry in Member States.

- **Developments in medical radiation physics quality assurance** (IAEA Project F3.04)

  The objective of this project is to improve quality assurance and dose auditing in Member States through the development of new techniques, methodologies and training material for use in QA and dose auditing.

A standing Scientific Committee established by the Directors General of the IAEA and WHO reviews and evaluates the work of the Dosimetry and Medical Radiation Physics Section and advises the Director General of the IAEA on the strategies of the Dosimetry Subprogramme of the IAEA that will meet the needs of the Member States. The 10th meeting of the Committee took place in Vienna from 25 February – 1 March 2002; their report was published in the SSDL Newsletter No. 47 (January 2003).

Services provided by the IAEA

The experimental work of the Dosimetry and Medical Radiation Physics Subprogramme is carried out in the IAEA's Dosimetry Laboratory, a unit integrated in the IAEA's Seibersdorf Laboratories. The Dosimetry Laboratory is the central laboratory of the IAEA/WHO network of SSDLs.

The range of laboratory services provided to Member States covers:

i) Calibration of ionization chambers (radiotherapy, diagnostic radiology including mammography, and radiation protection).
Radiation quality: X-rays (10 - 250 kV) and gamma rays from ^{137}Cs and ^{60}Co.

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

iii) 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.

iv) ESR-alanine dose quality audits for radiation processing (for SSDLs and facilities).
Radiation quality: gamma rays from ^{60}Co. Dose range: 0.1 - 100 kGy.

v) TLD dose quality audits for radiation protection (for SSDLs).
Radiation quality: gamma rays from ^{137}Cs and ^{60}Co.

vi) Reference irradiations for dosimeters for radiation protection, mainly for IAEA internal use.
Radiation quality: X-rays (40 - 300 kV) and gamma rays from ^{137}Cs and ^{60}Co.

Network of Secondary Standards Dosimetry Laboratories (SSDLs) (IAEA Project F3.01)

Membership in the IAEA/WHO SSDL network is open to laboratories designated by their national competent authority. The network presently consists of 75 laboratories and 6 SSDL national organizations in 63 Member States, of which more than half are developing countries. 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, brachytherapy (^{137}Cs), and diagnostic radiology including mammography. Some SSDLs occasionally provide quality audits of radiotherapy beams by postal TLD and on-site measurements, and some perform measurements for nuclear medicine. The implementation of such a programme requires that the traceability of the SSDLs to a PSDL or to the IAEA be verified periodically through quality audits and comparisons organized by DMRP.

The major accomplishment in support of the SSDL Network was to prepare and submit the IAEA’s Calibration and Measurement Capabilities (CMCs) to the Joint Committee of the Regional Metrology Organisations and the Bureau International des Poids et Mesures (JCRB) for acceptance into Appendix C of the Mutual Recognition Arrangement (MRA). The IAEA CMCs were reviewed by several Regional Metrology Organizations (RMOs) and finally accepted by the JCRB. They appear in the BIPM key comparison database. For air kerma and absorbed dose to water calibrations, the IAEA CMCs are supported by comparisons with the Regional Metrology Organization for the Americas (Sistema Interamericano de Metrologia, SIM). For medium energy calibrations, the IAEA is planning to participate in an APMP comparison (originally planned for September 2002 and postponed to March 2003).

As recommended by the SSC-10[1], the IAEA would like to participate in appropriate CCRI(I) dosimetry comparisons.

IAEA support to other SSDLs to demonstrate their CMCs

Following a recommendation by the SSC-10, a technical meeting was organized by the IAEA in Vienna with four SSDLs from Latin America who have participated in the SIM comparison. These are the SSDLs of Argentina, Brazil, Mexico and Venezuela. During the meeting, the results of the SIM comparison were reviewed as well as the SSDLs' CMCs. The PSDLs of Canada (NRC) and the United States (NIST) participated in the SIM comparison. Three ionization chambers (A12) were calibrated in terms of both air kerma and absorbed dose to water at all the participant laboratories. NRC acted as the pilot laboratory. The results show that all the calibrations for both quantities fall within an interval of 0.8%. Hence, it was concluded that the results of this comparison could be used to support the uncertainty claims for the Calibration and Measurement Capabilities (CMCs) of all the participating laboratories.

The participants noted the lack of a comparison programme in the field of x-ray dosimetry (therapy and protection level) and requested the IAEA to develop such a programme. It is planned to initiate a pilot study for the comparison of calibration coefficients in protection level x-ray dosimetry (ISO-4037 narrow spectra beams) in 2003.

Calibration of national measurement standards of the Member States

During 2001–2002, the IAEA calibrated 123 ionization chambers, of which 20% were for radiation protection level dosimetry and mammography and the remaining 80% for radiotherapy (including brachytherapy). A survey was conducted among the SSDL network members which showed that about 40% are traceable to the IAEA, 15% to the BIPM and 45% to other PSDLs.

Comparison of ionization chamber calibration coefficients for dose to water and air kerma

A proficiency testing programme that began in 1995 verifies the ability of SSDLs to transfer a calibration from their reference standard to the user. In this programme, the SSDL calibrates an ionization chamber of its choice, and forwards it to the IAEA for calibration. The chamber is returned to the SSDL where the calibration is repeated to ensure stability of the instrument during transit. Nine SSDLs participated in this ionization chamber comparison programme during 2001–2002 and the results are presented in Figure 1. Calibrations both in terms of air kerma and absorbed dose to water were included. The two participants exceeding the DMRP action level (1.5%) were contacted for follow-up action.

Many SSDLs have requested that the Agency expand this programme to include x-rays (protection and therapy level). A pilot study (with a limited number of SSDLs) is planned to be conducted in 2003 to test the feasibility of such a comparison programme.

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[1] Report of the 10th meeting of the SSDL Scientific Committee, SSDL Newsletter No. 47, January 2003.

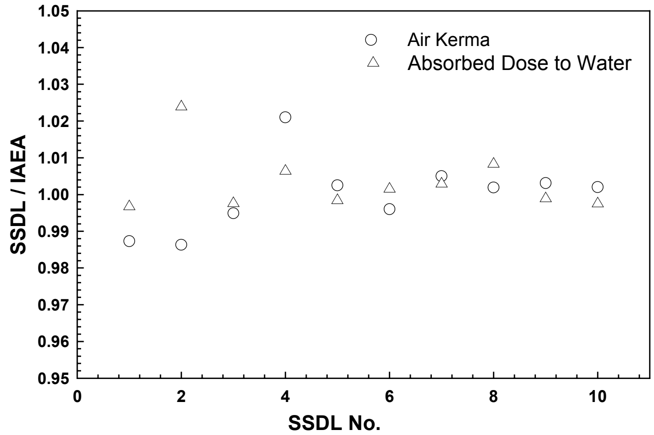

FIGURE 1. Ratios of ion chamber calibration coefficients supplied by the SSDLs to those measured by the IAEA. Circles correspond to air kerma calibration coefficients and triangles to absorbed dose to water factors.

Calibration of diagnostic radiology ionization chambers

A discrepancy between the calibration coefficient for our standard (Radcal 10X5-6M) provided by PTB and that provided by NIST was investigated. As a result, the ionization chamber was recalibrated at both PSDLs in 2001 in order to resolve the discrepancy. The maximum difference in N_k now for similar beam qualities is 0.3%, which is regarded as acceptable. The new traceability of our standard is based on calibration at PTB for beams from a molybdenum anode using a molybdenum filter. The traceability to NIST was established for beams generated from a molybdenum anode using a rhodium filter and for beams from a rhodium anode using a rhodium filter. The IAEA's Dosimetry Laboratory can offer calibrations at 17 different beam qualities altogether.

Twelve mammography chambers and two semiconductor detectors had been calibrated at the laboratory by the end of 2002. This meant establishing 238 values of N_k, which required considerable laboratory time. Starting from 2003, the number of radiation qualities has been reduced to 6-10 per calibrated instrument.

The IEC is preparing a new version of its 61267 document, and the latest draft shows considerable change in procedures for beam generation. At the IAEA's Dosimetry Laboratory, the experiments on the use of the new IEC 61267 procedures for RQR and RQA beam generation started in 2002. An Exradin A 3 ionization chamber was calibrated at PTB for RQR beam qualities. This chamber will be used as a laboratory standard for these beams. In addition, A 4 and A 5 chambers are considered for radiation qualities with a low air kerma rate (RQA beams).

The non-invasive high voltage meter for mammography was calibrated at PTB in 2001. The calibration coefficients in terms of practical peak voltage were established over the range 26–50 kV.

X-ray spectrometry

The shielding for the detector was designed and manufactured. The spectra from the laboratory x-ray machines were collected. In addition, the low energy x-ray spectra at BEV were measured. The major problem of x-ray spectrometry is the high fluence of photons interacting with the detector. This requires using a low tube current and long focus-to-detector distance. A low photon fluence is difficult to achieve with a mammography unit where the tube current is of the order of 100 mA and not under control. A possible solution is to restrict the beam diameter with a collimator and measure at large distances from the focus. A TRIAMED material (a tungsten alloy) was procured to replace the present lead collimators, which suffer because of poor hole shape and scattering of photons on the collimator edges. The beams will be measured at a distance of 3 m from the focus after passing through the evacuated tube.

EUROMET project on calibration of dosimeters used in mammography

The EUROMET project No. 526 is a co-operative research programme involving 14 European metrological institutes. The main objective of the project is to investigate the suitability of radiation qualities available at standards laboratories for the calibration of dosimeters used in mammography, according to the requirements of IEC 61674.

As a part of this project, selected dosimeters (two ionization chambers and two semiconductor detectors) were calibrated at participants' calibration beams. The calibration of dosimeters at the IAEA's Dosimetry Laboratory was conducted in 2001 and 2002. The results of this experiment have been evaluated and will be published in 2003.

TLD-based monitoring of SSDL measurements

Therapy level

The IAEA/WHO TLD postal dose quality audit service has monitored the performance of the SSDLs in the therapy dose range since 1981. Results of this programme indicate that more than 95% of the SSDLs that participate in the TLD audits 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 Fig. 2, where deviations from the IAEA's results are plotted for ^{60}Co and high energy X-rays. During the review period, four SSDL TLD runs (2000/2, 2001/1 and 2001/2, and 2002/1) were completed for 56 laboratories, in which 165 beams were checked (113 ^{60}Co and 52 high energy X-rays from medical accelerators).

For laboratories with deviations outside the acceptance limit, a follow-up programme was 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.

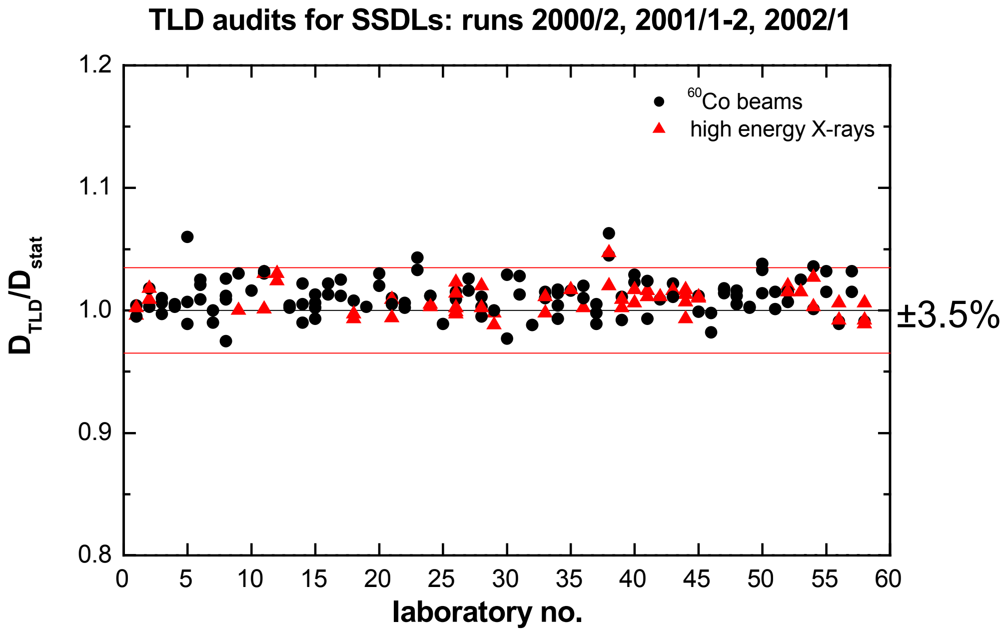

FIGURE 2. Results of the IAEA/WHO TLD postal dose audits for SSDLs for the delivery of dose to water under reference conditions for the TLD runs 2000/2, 2001/1, 2001/2 and 2002/1. Data in the graph correspond to the ratio of the IAEA's determined dose from the TL-response (D_{TLD}) to that stated by the SSDL (D_{stat}). Each data point corresponds to the average of three dosimeters. A total of 165 beam calibrations was checked in 56 laboratories, which include 113 ^{60}Co (circles) and 52 high energy x-ray beams (triangles). The number of therapy beams checked in different TLD runs was: 44 beams in 2000/2, 39 beams in 2001/1, 45 beams in 2001/2 and 37 beams in 2002/1. A total of 6 deviations was found outside the acceptance limit of 3.5% (one deviation in the 2000/2 run, none in the 2001/1 run, four in 2001/2 and one in 2002/1).

Protection level

This service for SSDLs calibrating with ^{60}Co and ^{137}Cs radiations started in 1999. It is organized in two runs per year, each run involving about 15 laboratories. In addition, selected PSDLs are supplied with a set of dosimeters and asked to irradiate them at prescribed levels of air kerma. These dosimeters are used as an independent check of the system. The SSDLs that are outside the acceptance limit are contacted and support is provided to resolve the discrepancies. As a routine, they are invited for the next run.

The results of the runs in 1999–2001 are given in Figure 3. They show that about 30% of the SSDLs participating for the first time are outside the acceptance limit set as 3.5%. This limit is probably too strict. Upon the recommendation of the SSC-10, the acceptance limit was changed to 5% starting in 2002. This corresponds to three standard deviations of TLD measurements in our laboratory.

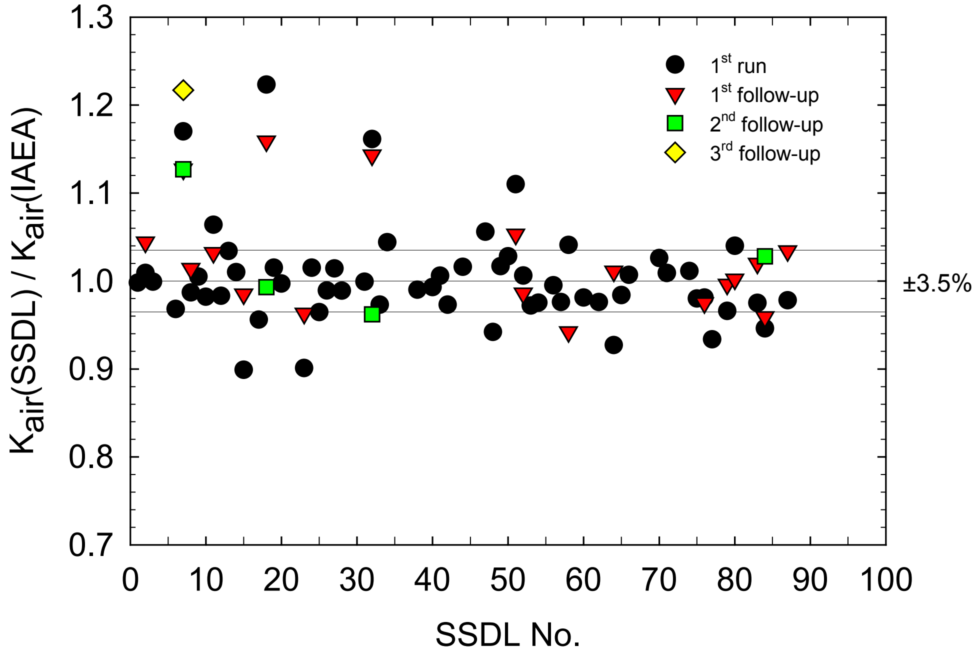

FIGURE 3. Ratios of the air kerma stated by SSDLs to the TLD measured value at the IAEA's Dosimetry Laboratory.

Measurements on personal dosimeters for IARC

A multinational epidemiological study, the International Collaborative Study of Cancer Risk among Radiation Workers in the Nuclear Industry, is currently underway, co-ordinated by the International Agency for Research on Cancer (IARC). The objective of this study is to obtain estimates of cancer risk following low dose protracted exposure to low-LET ionizing radiation. The study includes nuclear facilities from 17 countries in which workers were individually monitored for external radiation dose with the use of a personal dosimeter.

Overall, 124 different types of dosimeters have been used over time in the participating study facilities. This includes mainly film and thermoluminescent (TLD) dosimeters. Experiments were carried out at the IAEA's Dosimetry Laboratory to assess the response of dosimeters to energies and geometries similar to those existing under normal working conditions. Ten types of old and new dosimeters were selected. These represent one of the three dosimeter categories that have been used for personnel monitoring over the years: film dosimeters with one or two filters, multi-element film dosimeters and TLD dosimeters. The ISO x-ray beam qualities N-150, N-250, and ^{137}Cs and ^{60}Co gamma-rays have been used to irradiate the dosimeters placed on the ISO water phantom and an anthropomorphic Rando phantom. A special device was designed and constructed that allows rotating the Rando phantom in the radiation field. It was used to simulate rotational and isotropic geometries of irradiation.

The results of experiments are in agreement with what was expected: major over and underestimation of doses were obtained with old dosimeters irradiated to low energy photon radiation (see Figure 4). The relative response of modern dosimeters was in general close to 1. The results will be used to correct dosimetry data from various facilities.

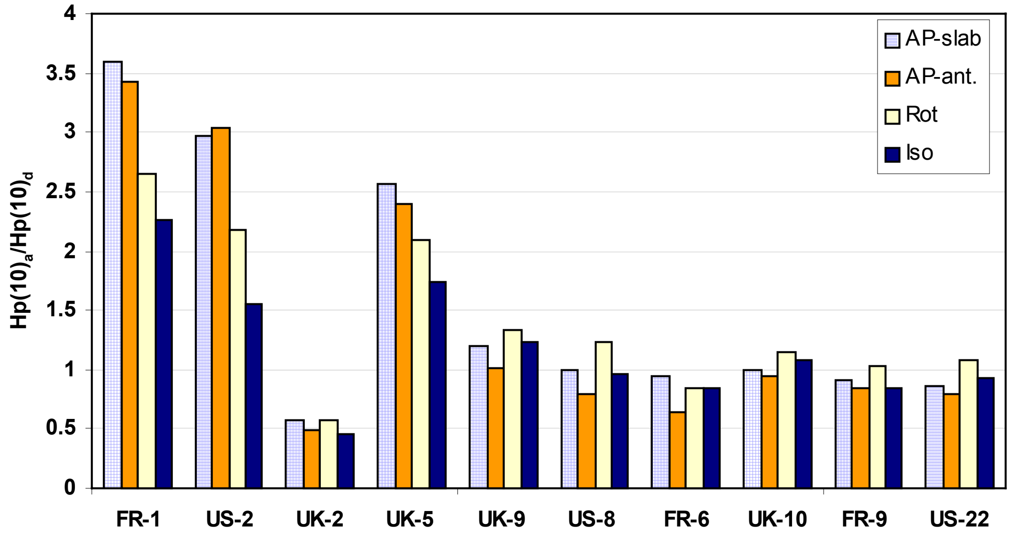

FIGURE 4. Response of dosimeters to 118 keV photon radiation. "AP-slab" means anterior–posterior irradiation on the ISO slab phantom. "AP-ant" refers to anterior–posterior irradiation on the anthropomorphic phantom. "Rot" means rotational geometry of irradiation for the anthropomorphic phantom, and "Iso" means isotropic geometry of irradiation for the anthropomorphic phantom.

Brachytherapy calibrations

A calibration service for brachytherapy well type ionization chambers for ^{137}Cs sources has been available since 1996. The IAEA standards consist of two sources, models CDC1100 and CDCS J5, both of them calibrated at the NIST.

In 2001, the IAEA and the SSDL of Finland (STUK) carried out a comparison of well type chamber calibrations for Low Dose Rate ^{137}Cs quality. The table below shows the results of the comparison.

TABLE 1. Ratios between STUK and IAEA calibrations of a well type chamber.

Source	Ratio STUK/IAEA
CDCS J5	0.996
CDC1100	0.989

It may be mentioned that STUK uses model CDC700 for their calibration service. This model is not identical to either of the sources used by the IAEA, however, its construction more closely resembles that of CDC1100 than CDCS J5. The uncertainties of the ratios are 2% (k=1).

During the reporting period, five well type chambers were calibrated.

Quality assurance and dose audits to end-users (IAEA Project F3.02)

Dose quality audits are conducted for radiotherapy centres and industrial facilities. In both services, users are requested to irradiate the dosimeters with a given dose under known irradiation conditions; the dosimeters are then returned to the IAEA for evaluation.

The IAEA/WHO TLD postal service

In 2001–2002, the IAEA/WHO TLD postal dose audit service for hospitals continued its previous development related to improving the organization and efficiency of the service. The automation of the TLD system allowed shortening the time of TLD evaluation and increasing the number of hospitals monitored to 300–400 per year. Due to the joint efforts of IAEA and WHO, the return rate of the irradiated dosimeters is now approximately 95%.

During the review period of 2001–2002, the TLD programme audited 845 beams in 439 radiotherapy centres. The global results are shown in Figure 5. Approximately 84% of the results are within the acceptance limit of 5%.

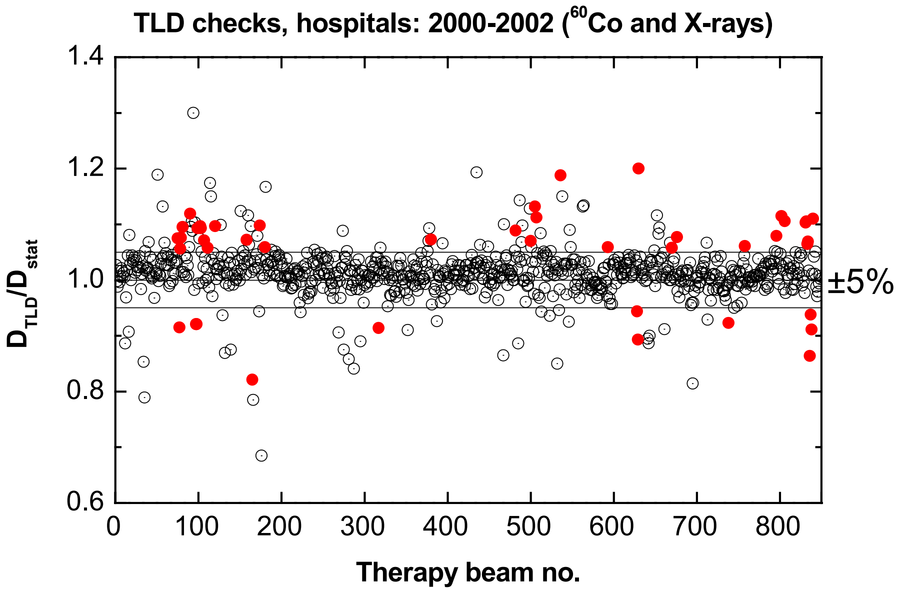

FIGURE 5. Results of the IAEA/WHO TLD postal dose audits of radiotherapy hospitals for the delivery of absorbed dose to water under reference conditions for TLD batches B116 to B138 (from July 2000 to October 2002). Data in the graph correspond to ratios of the IAEA's determined dose (D_{TLD}) relative to the dose stated by the hospital (D_{stat}). Each data point corresponds to the average of two dosimeters. A total of 845 beam calibrations was checked in 439 hospitals. Approximately 16% of the results were found outside the 5% acceptance limit. Of these 11% were corrected in the subsequent follow-up action. The darkest dots indicate the remaining 5% of the results that had not been corrected by January 2003.

The follow-up procedure to resolve discrepancies has been strengthened through closer contact with local experts where available (mainly from SSDLs), or by recruitment of external experts in medical physics. Thanks to the follow-up action, the percentage of acceptable results increased to 95% in 2001–2002, although 44 deviations (5%) remained uncorrected either due to a failure to respond to the IAEA efforts or due to local problems that could not be resolved without allocation of appropriate resources.

At present, the main focus in the TLD programme is given to expanding the service to new hospitals as the number of radiotherapy facilities in the world continuously increases. In 2001–2002, 184 additional radiotherapy centres joined the TLD network. Only 73% of the hospitals that received TLDs for the first time had results within the 5% acceptance limit, while 89% of institutions that benefited from a previous TLD audit had results within the 5% limit. The percentage of the results beyond the 10% limit is twice as high for the new hospitals (9%) as for those having participated in the audits (4%).

To provide appropriate QA of the TLD system, in addition to contacts with BIPM and PSDLs, systematic collaborations with other TLD-based QA networks in Europe and USA have been maintained. The "Memorandum of Understanding" between the Agency and the EQUAL/ESTRO TLD network enables mutual exchange of TLDs for reciprocal quality control of TLD systems and it facilitates co-ordination of the activities of TLD audit services in Europe.

The IAEA continues to assist Member States to establish national TLD programmes and whenever possible, establishes links between the national programmes and the IAEA's Dosimetry Laboratory. In 2001 a new Co-ordinated Research Project (CRP E2.40.12) was initiated for national TLD audits in non-reference conditions, thereby continuing the previous CRP "Development of a TLD based quality assurance programme for radiation therapy dosimetry in developing countries", which dealt with TLD audits under reference conditions.

Comparison of TLD systems for measurements in mammography

A Co-ordinated Research Project on "Image quality and patient dose optimization in mammography in Eastern European Countries" was conducted by the IAEA, aimed at defining a methodology for the implementation of a quality assurance programme in mammography and exercising the assessment of image quality and patient doses in a sample of hospitals in Eastern European countries. A comparison of dosimetry systems was organized to assure that dose measurements done within the framework of the project are comparable. The thermoluminescent method was selected for the comparison. The dosimeters were irradiated free-in-air to values of air kerma in the range of 5-9 mGy and mailed to the participants for evaluation. Deviations of measured values from the true values by less than 10% were considered as a measure of "good dosimetry performance" of the participants. The results of the comparison showed that about 70% of reported values of air kerma were outside the 10% acceptance limit. Two follow-up exercises were organized. The first follow-up resulted in only 20% of reported values exceeding the limit, and during the second follow up all results were within the acceptance limit (Figure 6).

The International Dose Assurance Service (IDAS) for industrial applications

The International Dose Assurance Service (IDAS) performs dose quality audits for the SSDLs, the industrial and pilot-scale facilities, and research laboratories used for radiation processing applications. The service is limited to ^{60}Co gamma rays. The overall uncertainty of the alanine-ESR dosimetry system used for this service is 1.7% (k=1). The performance of this dosimetry system is compared with that of a PSDL about once a year, which provides an external quality control. Alanine-ESR dosimeters, supplied by the IAEA, are irradiated at the facilities or laboratories at radiation doses relevant to industrial applications (0.1 to 100 kGy) and then returned for evaluation to the IAEA. The reference irradiation conditions are monitored and this information is forwarded to the IAEA along with the dose values. The dosimeters are then analyzed at the IAEA and the results compared with the stated values. IDAS thus provides an independent check of the entire dosimetry system of the participant. In case of a discrepancy greater than 5%, advice is provided as to its possible causes and this is followed by another dose check. Figure 7 shows the results for the last two years. A total of 91 dose checks were performed and approximately 22% of the results were found outside the 5% acceptance limit.

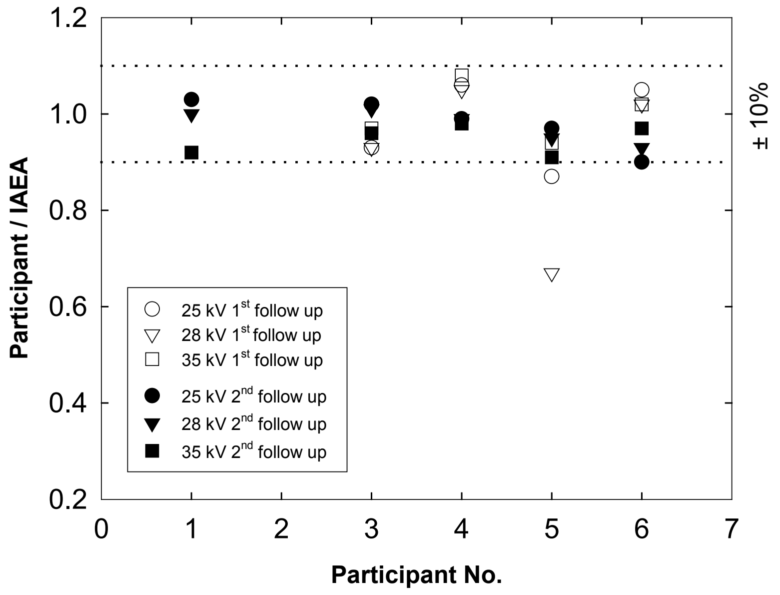

FIGURE 6. Ratios of the air kerma stated by the participant to the reference value provided by the IAEA's Dosimetry Laboratory for irradiation of TLDs in beams generated by a molybdenum anode with a molybdenum filter during the two follow-up tests.

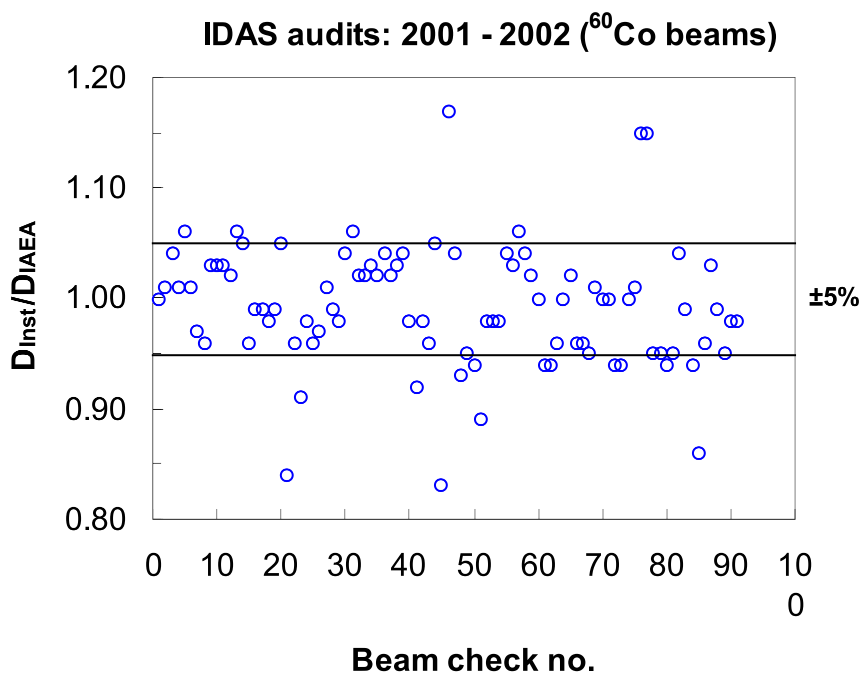

FIGURE 7. Results of the IDAS dose audits for the years 2001 and 2002. Data in the graph correspond to ratios of the dose stated by the institution (D_{inst}) relative to the IAEA's determined dose (D_{IAEA}). Each data point represents the average of three dosimeters.

Research and development in radiation dosimetry techniques (IAEA Project F3.03) and Developments in medical radiation physics quality assurance (IAEA Project F3.04)

As of 2003, research and development projects used to support the SSDLs are dealt with under project F3.03 and those used to support quality assurance and dosimetry auditing are under project F3.04. The transfer of dosimetry techniques to Member States is provided through co-ordinated research projects (CRPs), the holding of meetings, training courses, fellowships, seminars and symposia and publication of research done. The maintenance of computer databases also belongs to these projects.

Co-ordinated Research Projects

Table 2 provides a compilation of the CRPs within the Subprogramme that were operational during the reporting period.

TABLE 2. Co-ordinated Research Projects (CRPs) in Dosimetry, operational in 2001–2002.

Year of commencement	CRP code and title	Year of completion	Participating institutions
1995	**E2 40 07:** Development of a quality assurance programme for radiation therapy dosimetry in developing countries. CRP extended and additional members added.	2001	13
1997 *2001*	**E2 40 09:** Development of a Code of Practice for dose determination in photon, electron and proton beams on measurement standards of absorbed dose to water. TRS-398 published. *Extension of the CRP to test the COP at hospitals.*	2000 *2002*	7 *5*
1998	**E2 40 11:** EPR Biodosimetry (jointly with the Division of Radiation and Waste Safety).	2002	8
2000	**E2 10 03:** Dosimetry in x-ray diagnostic radiology: an international Code of Practice.	2004	5
2001	**E2 10 04:** A new CRP was submitted and approved for 2001-2003: it supports the development of techniques at the SSDLs for the dissemination of the new standards based on absorbed dose to water for radiotherapy dosimetry.	2004	6
2001	**E2 40 12:** Development of TLD-based quality audits for radiotherapy dosimetry in non-reference conditions	2006	9

Training courses

Considerable emphasis is placed by the Dosimetry and Medical Radiation Physics Section on organizing training courses and co-ordinating fellowships for medical radiation physicists and staff from SSDLs within the framework of IAEA Technical Co-operation projects.

The courses and workshops held during 2001–2002 were as follows:

2001

i) Regional training course on implementation of the protocol for the physical aspects of quality assurance in radiotherapy, Cordoba, Argentina, 1–12 October.

ii) Regional workshop on use of treatment planning systems type Theraplan Plus, Freiburg, Germany, 8-12 October (RAF/6/027).

iii) Regional workshop on the calibration of protection level dosimetry instruments, Riga. Latvia, 8-12 October (RER/1/004).

2002

i) Regional training course on clinical dosimetry, Caracas, Venezuela, 21 January – 1 February.

ii) Regional workshop on quality assurance in radiotherapy: physical and technical aspects, Dar es Salaam, Tanzania, 15-19 April (RAF/6/027).

iii) Regional workshop on the implementation of TRS-398, Tunis, Tunisia, 29 April – 3 May (RAF/6/027).

iv) Regional workshop on quality assurance for treatment planning systems, Rabat, Morocco, 3–8 June (RAF/6/027).

IAEA publications in dosimetry and medical radiation physics

An IAEA SSDL Newsletter is published biannually and distributed among the members of the SSDL network and the scientific community. The Newsletter is also available on the Internet.

TABLE 3. IAEA publications in dosimetry and medical radiation physics, published 2001–2002. (Does not include refereed publications in the archival literature.)

Series and No.	**Title**
STI/PUB/1113	Radiological Protection of Patients in Diagnostic and Interventional Radiology, Nuclear Medicine and Radiotherapy. Proceedings of an International Conference held in Málaga, Spain, 26–30 March 2001, organized by the IAEA and co-sponsored by the EC, PAHO and WHO (2001).
STI/PUB/1114	Investigation of an Accidental Exposure of Radiotherapy Patients in Panama: Report of a Team of Experts, 26 May – 1 June 2001 (2001).
SSDL Newsletter Nos. 44 and 45 (2001)	—
IAEA Bulletin, 43/2/2001	Improving cancer care: increased need for radiotherapy in developing countries, pp. 25-32 (2001)
SSDL Newsletter No. 46 (2002)	—
SSDL Newsletter No. 46	Calibration factor or calibration coefficient?, pp. 33-34 (2002)
IAEA-TECDOC-1274	Calibration of Photon and Beta Ray Sources used in Brachytherapy. Guidelines on Standardized Procedures at Secondary Standards Dosimetry Laboratories (SSDLs) and Hospitals (2002). *This supersedes TECDOC-1079.*
IAEA-TECDOC-1331	Use of Electron Paramagnetic Resonance Dosimetry with Tooth Enamel for Retrospective Dose Assessment, Report of a Co-ordinated Research Project (2002).

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 and its last edition was published in 1968. The present electronic version of the Directory of Radiotherapy Centres (DIRAC) is a joint effort with WHO. It is updated continuously, based on replies to questionnaires circulated to users. It 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 DIRAC database was released in electronic form (Access 2000) for internal use and the Internet version is in preparation. The DIRAC data are verified and updated on a routine basis.

Appendix 1: Report on International Symposium on Standards and Codes of Practice in Medical Radiation Dosimetry

The International Symposium on Standards and Codes of Practice in Medical Radiation Dosimetry was organized by the Agency in Vienna from 25 to 28 November 2002 to foster exchange of information and highlight recent advances in research in this field. Over 250 scientists from 62 Member States attended the Symposium, at which 140 presentations were delivered covering a broad range of topics in medical radiation dosimetry.

A key issue addressed by the Symposium was knowledge of the accuracy of radiation doses delivered to patients, which is essential for the safe and effective diagnosis and treatment of disease. Such accuracy in dose measurement is an integral part of a comprehensive quality assurance programme to ensure that the technology is used properly and has the intended effect on patients.

The co-sponsoring organizations of the Symposium were the EC, ESTRO, IOMP and PAHO. Collaborating organizations included AAPM, EFOMP, ISRO, ICRU and WHO. Ten companies participated in a scientific exhibition of equipment relevant to medical radiation dosimetry and the treatment of cancer. One of these companies arranged for the display of a cobalt therapy machine, which was located in the rotunda of the Vienna International Centre during the Symposium.

A special plenary session entitled “Meeting the Needs” focused attention on the impending crisis in cancer management. A speaker from the International Agency for Research on Cancer indicated that cancer incidence within developing countries is expected to increase by 50% within the next decade, primarily due to population ageing. In the discussion following this special session, representatives of the manufacturers participating in the equipment exhibition, as well as speakers and delegates tried to identify appropriate and affordable technologies and to define possible roles for the Agency to help in transferring equipment and developing local expertise required to meet the needs arising out of this crisis.

Recommendations from the Symposium sessions were presented for discussion and approval by participants in the final session, which was chaired by Penny Allisy. All the recommendations are listed in a separate annex to this report entitled “Dosimetry Symposium Recommendations”. Although many of the recommendations concern the scientific community, some are directed to governments and industry as these affect the practical application of nuclear technology in the healthcare sector in both developing and developed countries. Several themes appear consistently throughout the various recommendations such as the importance of education and training required for healthcare workers to diagnose and treat patients safely and effectively. In addition, The Symposium recognized that:

- appropriate and affordable equipment is required to meet the needs of developing countries in particular, with manufacturers as partners in the process of technology transfer;

- it is essential for treatment methodologies to be supported by infrastructural services in medical physics and diagnostic radiology; and

- programmes in quality control and assurance should provide the necessary auditing tools to demonstrate the safe and effective application of nuclear technology for patients.

Explicitly within the field of medical radiation dosimetry, the Symposium made recommendations:

- for the further development of physical standards; and
- for performance comparisons, and participation in audits by end-users and primary and secondary standards dosimetry laboratories in the sub-fields of nuclear medicine, brachytherapy, proton therapy and clinical dosimetry.

There are recommendations for primary and secondary standards dosimetry laboratories:

- to develop further their absorbed dose to water standards and air kerma standards;
- to refine the assessment of the uncertainties on the physical standards; and
- to participate in comparison exercises in order to build confidence in their measurement capabilities.

A recommendation was made to enhance the application of the Agency's dosimetry code of practice for external beam therapy, TRS-398, and to complete the development of a new code for diagnostic radiology.

Work is under way to complete the process of refereeing and editing the proceedings of the Symposium, which will comprise about 85 papers and include the recommendations.

A Technical Meeting will be convened at the Agency 30 June and 1 July to prepare an action plan in response to the recommendations of the Symposium.

Appendix 2: Non-IAEA publications co-authored by staff members of the IAEA Dosimetry and Medical Radiation Physics (DMRP) Section, 2001–2002

2001

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