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IAEA/WHO Network of Secondary Standards Dosimetry Laboratories

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Contents

Calibration of an ionization chamber in terms of absorbed dose to water at the SSDL of Bangkok, Division of Radiation & Medical Devices, Department of Medical Sciences (courtesy of S. Smiranoroth)

From the editor

Prof. Rethy Chhem has been appointed the new Director of the Division of Human Health. He holds a MD, a PhD in Education (Comparative and International Education) and a PhD in History of Medicine (Public Health). He has conducted extensive research in musculoskeletal radiology and medical education. Before his recruitment, he was Chief of the Radiology Dept. at the London Health Science Centre and Chair of the Dept. of Diagnostic Radiology and Nuclear Medicine at the University of Western Ontario, Canada.

This issue of the SSDL Newsletter contains two meeting reports. The first one describes the 13th meeting of the Scientific Committee of the IAEA/WHO SSDL Network, held in Vienna in March 2008. The second report was prepared by a group of consultants and provides guidelines on the auditing of SSDLs. In addition, a brief overview of the results of an IAEA survey on the status of calibrations in X ray diagnostic radiology is included. Furthermore, information is also given on an upcoming IAEA-ICTP course on dosimetry in X ray diagnostic radiology.

A new format for the annual report by SSDLs will be introduced. As of 2009, SSDL members will have the possibility to submit their annual report in a structured electronic form using an on-line web based account or by e-mail. SSDL members are encouraged to use the on-line submission to facilitate the transfer of the reported data to the IAEA/WHO SSDL network database. A circular letter providing additional details will be distributed electronically to all SSDL members.

IAEA International Atomic Energy Agency

STAFF OF THE DOSIMETRY AND MEDICAL RADIATION PHYSICS (DMRP) SECTION

International Atomic Energy Agency, Wagramer Strasse 5, P.O. Box 100, A-1400 Vienna, Austria
Telephone: (+43-1) 2600+extension; Fax: (+43-1) 26007, e-mail:Official.Mail@iaea.org

Name	*Position/tasks*	*E-mail address*	*Extension*
Meghzifene, Ahmed	SSDL Officer, Acting Section Head Editor, SSDL Newsletter	a.meghzifene@iaea.org	21653
Godrey Azangwe	Dosimetrist	g.azangwe@iaea.org	28384
Bera, Pranabes	Senior Laboratory Technician, TLD	p.bera@iaea.org	28330
Czap, Ladislav	Senior Laboratory Technician Ionization chamber calibration	l.czap@iaea.org	28332
Girzikowsky, Reinhard	Senior Laboratory Technician High dose and mammography	r.girzikowsky@iaea.org	28328
Izewska, Joanna	TLD Officer, Head, Dosimetry Laboratory Unit	j.izewska@iaea.org	21661
Kesner, Adam	Junior Medical Radiation Physicist	a.kesner@iaea.org	21655
McLean, Ian Donald	Medical Radiation Physicist Diagnostic Radiology	i.mclean@iaea.org	21663
Palm, Stig Harald	Medical Radiation Physicist	s.palm@iaea.org	21659
Vatnitsky, Stanislav	Medical Radiation Physicist Treatment planning systems	s.vatnitsky@iaea.org	21660
Holan, Mary Frances	Secretary	m.holan@iaea.org	21662
Danker, Sabine	Secretary/Clerk	s.danker@iaea.org	21665
Ciortan, Simona	Secretary/Clerk	s.ciortan@iaea.org	21634
DMRP Section*		Dosimetry.Contact-Point@iaea.org	21662

* This is the e-mail address to which messages on dosimetry and medical radiation physics in general should be addressed, i.e. correspondence not related to specific tasks of the staff above. Each incoming general correspondence to the DMRP Section mailbox will be dealt with accordingly.

SERVICES PROVIDED BY THE IAEA IN DOSIMETRY AND MEDICAL RADIATION PHYSICS

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

The IAEA Calibration and Measurement Capabilities (CMCs) have been reviewed and published in the CIPM's (Comité International des Poids et Mesures) Appendix C. The Dosimetry Laboratory's Quality Management System has been reviewed and accepted by the Joint Committee of the Regional Metrology Organizations and the BIPM (JCRB).

Additional information can be found at the following web site: http://kcdb.bipm.org/AppendixC/search.asp?met=RI

The range of services is listed below.

Services	*Radiation quality*
Calibration of ionization chambers (radiotherapy, diagnostic radiology including mammography, and radiation protection including environmental dose level)	X rays (10–300kV)* and gamma rays from ^{137}Cs and ^{60}Co
Calibration of well type ionization chambers for low dose rate (LDR) brachytherapy	γ rays from ^{137}Cs **New sources were purchased and source of traceability will be changed from NIST to PTB (effective January 2009).**
Comparison of therapy level ionization chamber calibrations (for SSDLs)	γ rays from ^{60}Co
TLD dose quality audits for external radiotherapy beams for SSDLs and hospitals	γ rays from ^{60}Co and high energy X ray beams*
TLD dose quality audits for radiation protection for SSDLs	γ rays from ^{137}Cs
Reference irradiations to dosimeters for radiation protection	X rays (40–300 kV)* and γ rays from ^{137}Cs and ^{60}Co beams

*** Calibrations in X ray beams will not be available till May/June 2009, because of X ray equipment replacement**

Member States who are interested in these services should contact the IAEA/WHO SSDL Network Secretariat for further details, at the address provided below. Additional information is also available through the Internet at the web site: http://www-naweb.iaea.org/nahu/dmrp/ssdl.asp.

IAEA/WHO SSDL Network Secretariat
Dosimetry and Medical Radiation Physics Section
Division of Human Health
Department of Nuclear Sciences and Applications
International Atomic Energy Agency
P.O. Box 100
A-1400 Vienna
Austria

Telephone: +43 1 2600 21662
Fax: +43 1 26007 21662
E-mail: Dosimetry.Contact-Point@iaea.org

Note to SSDLs using IAEA calibration services:

1. To ensure continuous improvement in IAEA calibration and audit services, SSDLs are encouraged to submit suggestions for improvements to the Dosimetry Contact Point.
2. Complaints on IAEA services can be addressed to the Dosimetry Contact Point.

Scientific Committee of the IAEA/WHO Network of Secondary Standards Dosimetry Laboratories

Report of the Thirteenth Meeting of the SSDL Scientific Committee

IAEA, Vienna
10-14 March 2008

1. FOREWORD

The Scientific Committee (SSC) of the IAEA/WHO network of Secondary Standards Dosimetry Laboratories (SSDLs) is a standing committee within the framework of the International Atomic Energy Agency. It is tasked with conducting periodic reviews and evaluations of the Dosimetry and Medical Radiation Physics Subprogramme and reporting the results of the reviews to the Director General of the IAEA and the WHO. The report of the twelfth meeting (held in March 2006) of the SSC (SSC-12) was published in the SSDL Newsletter No. 52 in July 2006.

The thirteenth meeting was held in Vienna at IAEA Headquarters from 10-14 March 2008. Opening remarks were made by Mr Pedro Andreo, Director of the Division of Human Health (NAHU); Mr Christian Schmitzer on behalf of Ms Gaby Voigt, Director of the Agency's Laboratories at Seibersdorf (NAAL); Mr Steffen Groth (WHO), Acting Co-Secretary of the IAEA/WHO SSDL Network; and Mr Ahmed Meghzifene, Acting Head of the Section of Dosimetry and Medical Radiation Physics (DMRP) and Co-Secretary of the IAEA/WHO SSDL Network.

1.1 Introductions

Mr Pedro Andreo opened the meeting with words of welcome to the newly constituted SSC-13. He expressed the view that, as many factors were new both in the DMRP and in the SSC, extra efforts would be needed to produce a synergy. He introduced each of the new members of the SSC-13 to the DMRP staff. Apologies had been received from the ICRU representative unable to be present and a further new member who was an expert in diagnostic radiology had also been unable to join the meeting but had submitted a contribution to the SSC-13 in writing. Mr Steffen Groth was warmly welcomed back to the VIC as the Acting WHO Secretary of the SSDL Network. Unfortunately, Mr Werner Burkart was on unexpected duty travel and so could not attend the introduction but he was present at the debriefing and gave his support for the work of the SSC-13.

Mr Andreo stressed the importance of the SSC for the DMRP sub-programme. The Committee had been set up under an agreement between the WHO and the IAEA many years ago. It had originally been intended for only SSDL matters, specifically the Network concept, but was extended to all activities of the DMRP about 12 years ago. Following the change the SSC was then expected to oversee all the sub-programme activities, and this has certainly had a positive impact on the development of the programme. Mr Andreo pointed out that no other section of the IAEA at this level has such a committee, and its work definitely helps with the coherency of the sub-programme. He had considered the idea of having one committee to oversee the whole of the Division programme but this had not proved possible as the IAEA already has many committees. However, he had managed to keep the SSC functioning as its advice to both the IAEA and the WHO is considered to be very important.

Since the last SSC in 2006 there has been a clear trend from Member States in that they are now making more requests for the sub-programme work, especially for TC projects. Consequently, the composition of the SSC-13 has a more clinical profile and the staff has also changed to reflect this demand. Don McLean and Stig Palm have joined the DMRP for their diagnostic radiology and nuclear medicine expertise, respectively. Mr Andreo continued by saying that striking a balance between the laboratory work and the hospital physics aspects is very important.

Mr Andreo said that he was looking at the SSC-13 to provide recommendations for the programme in the new biennium cycle for 2010 to 2011. Looking back at the previous recommendations, he was pleased to announce that ten of these had been fully implemented, nineteen were in progress and only three had not been implemented. He expressed the wish that the SSC-13 would not produce such a long list as the SSC-12 and if new work was proposed, it should be prioritised against the existing programme, manpower and funding. He

also asked that the SSC-13 recommendations should be placed in priority order. He closed his presentation by wishing the committee a productive and exciting meeting.

Mr Christian Schmitzer, who was representing Ms Gaby Voigt, Director of the Agency's Laboratories and who had been called away from the IAEA at short notice, welcomed the SSC-13 on her behalf. Although he was from the safeguards analytical laboratory he had previously been responsible for the Austrian SSDL so did understand the background of the committee's work. He had been much impressed on reading the previous reports of the SSC by the width and breadth of topics that had been covered. He noted that the SSC was founded in 1986 but it was in 1988 that the DG had appointed it as a standing committee and so it was now celebrating its 20th anniversary which is indeed an event of note. Some other committees serving so long have become 'clubs' but the SSC still seems to be very active which is highly commendable and a good example of the epithet 'Atoms for Peace'.

In 2006, the SSC-12 had already identified a number of topics which deserved attention, in the change from laboratory work to an increased emphasis on clinical aspects. One significant achievement over the last two years has been the inauguration of the new bunkers at the laboratory. A further important achievement is the recognition of the IAEA's calibration and measurement capabilities under the CIPM MRA. He remarked that the challenge for the present SSC would be to find the balance between sustainability of the programme and the new challenges.

Mr Andreo agreed with the last comment but added that the use of the term 'Atoms for Peace' was short-hand for the full phrase 'Atoms for Peace, Health and Prosperity' and he always used the short-hand of 'Atoms for Health' and encouraged the committee to use this too. He stressed that Human Health is the largest activity of the IAEA in the Technical Cooperation projects (TC) as over 30% of the TC project funding for 2006-2007 was in this field. He recommended that the SSC focus their recommendations accordingly on this and the '20/20 programme' of the IAEA.

Mr Steffen Groth, Acting Co-Scientific Secretary of the SSDL Network, then spoke on behalf of the WHO. He thanked the SSC and the DMRP for their work and in speaking of balance and the WHO's contribution, he wondered if he had the right to continue to discuss whether the IAEA was doing the right thing and in the right place. He stressed that the WHO gives their highest priority to primary health care whereas he felt that the IAEA should continue to support health care at the tertiary level in their Member States. By doing this they provided the technology and training necessary to keep medical and support staff in post in their own countries while enhancing the opportunities for improved cancer care for their populations.

He commented that the developing countries are in real need of improvements in health care and we should constantly question whether the activities being discussed in the programme being run by the DMRP could do more to make a real difference. He feels that some undoubtedly are making a positive difference and these activities are more likely to be completely different from those for the developed countries. Radiation medicine for diagnosis and therapy promoting human health is really the most important aspect of the IAEA programmes outside nuclear power and the WHO attaches great importance to this.

He continued by saying that quality assurance (QA) and safety aspects, although closely related were actually completely different conceptually. He used a target shooting competition analogy to explain this indicating that QA was the increasing ability to hit the bull's-eye whereas safety was simply to avoid hitting the area surrounding the target. He was concerned that some people who have never been involved with patients believe that safety is more important than QA and he strongly supports close collaboration between the IAEA and the WHO to ensure there is a good balance in understanding of these issues. He stressed that the IAEA needs to be seen to be doing the right thing in the right place and that authority should be given to the activities to facilitate the support needed, noting that WHO is a health programme in a political setting. He felt it was important to have appropriate specialists in post at the IAEA and encouraged the IAEA in their present recruitment drive.

Mr Andreo commented that he concurred with the WHO view on 'safety' but that radiotherapy was not just about hitting the correct target but in doing this while damaging as little of the healthy surrounding tissue as possible. He promoted the use of 'as high as reasonable achievable' (AHARA) for radiotherapy in contrast to the more widely known acronym ALARA for 'as low as reasonable achievable'. With the advent of the Programme of Action for Cancer Therapy (PACT), he felt that the IAEA should be providing appropriate cost/benefit support to the Member States, which would also mean adequate diagnostic facilities to identify cancers at an early stage. Consequently, he felt the subprogramme should include a strong component of medical imaging.

Mr Ahmed Meghzifene, in his role of Acting Head of the DMRP, and as Co-Secretary of the SSDL Network, welcomed the SSC-13 to the meeting. He explained that the meeting would take place in three distinct parts, the first of which would be the presentation of the activities of the DMRP-run projects in 2006 to 2007 and he made a tribute to Mr Ken Shortt who had recently left the DMRP having been the Section Head for six and half years. The second part of the meeting would be devoted to the projects for 2008 to 2009, presently being implemented, and an overview of the result of a brain-storming session to feed into the biennium pro-

jects for 2010 to 2011. The final part of the meeting would be the deliberations of the SSC resulting in their report on the sub-programme and recommendations for the next biennium.

He then introduced Ms Penelope Allisy of the BIPM as the Chairman of the SSC-13.

In her first duty as Chairman, Ms Allisy thanked all four speakers for their support of the SSC and for their messages that would be heeded during the discussions. She noted in particular the plea from Mr Andreo for the prioritization of the new recommendations and the balance needed for the type of work to be undertaken so as to reflect the needs of Member States. The concept of balance that had been reiterated by both Mr Schmitzer, between continuing projects and new projects and Mr Groth, between imaging and therapy and QA versus safety, would also be carefully considered during the SSC-13 deliberations.

1.2 General discussion

1.2.1 Programme of the Meeting

Mr Meghzifene began the meeting programme by presenting an overview of the DMRP Subprogramme. Several DMRP staff members then presented reports on the activities of the Section during the remainder of the first day of the meeting. These reports continued throughout the morning and into the afternoon of the second day. On the third day, the SSC-13 met in closed session, deliberating on the accomplishments and direction of the IAEA's sub-programme, and developing specific recommendations. Discussion continued on the draft recommendations on the morning of the fourth day, including consideration of the written comments submitted, after which the SSC-13 was given a tour of the DOL and the laboratory facilities at Seibersdorf. During the morning and early afternoon, two of the SSC-13 members were excused from the SSC meeting to conduct an audit of the Dosimetry Laboratory (DOL). In the late afternoon of the fourth day, the SSC-13 continued to develop the recommendations, and also received a preliminary report from the two members who had conducted an audit of the DOL. The morning of the fifth and last day was spent refining the recommendations. The main draft recommendations were discussed with Mr. Meghzifene, the DMRP staff, Mr. Andreo and Mr. Burkart on the afternoon of the last day. During the feedback, the SSC-13 thanked the DMRP staff for their report and for their clear presentations.

In preparation for its report, the SSC-13 reviewed the activities reported by the DMRP for the 2006–2007 biennium and discussed the planned sub-programme activities for 2008–2009. In addition, the SSC reviewed an initial proposal for the biennium 2010–2011. The scope of the SSC-13 evaluation was similar to that of previous SSCs and addressed the questions of:

- The objectives of the sub-programme areas.
- The impact (benefit to the Member States).
- Opportunities to reduce costs by eliminating projects or transferring them to other laboratories.
- The continuing relevance of IAEA activities.
- The distribution of effort between work on the sub-programme projects and support of the laboratory quality management system.

Specific recommendations from the SSC-13 are underlined throughout the text, and are also reiterated at the end of the report, with an indication of their priority.

2. INTRODUCTION

The SSC-13 wishes to thank the DMRP staff members for preparing a comprehensive report covering the activities of the sub-programme on Dosimetry and Medical Radiation Physics during the biennium 2006-2007. The availability of this report well in advance of the meeting enhanced the Committee's ability to develop thoughtful and appropriate recommendations.

The SSC-13 is pleased to note that ten of the recommendations of SSC-12 have been fully implemented and nineteen are in progress. The SSC notes that the DMRP intends in the current biennium to complete implementation of the SSC-12 recommendations that are currently in progress.

During the biennium 2006-2007, the DMRP Section's projects and their titles were:

- Recurrent Project F4.01: Quality audits in radiotherapy dosimetry
- Recurrent Project F4.02: Radiation metrology supporting the network of Secondary Standards Dosimetry Laboratories (SSDLs)
- Project F4.03: Dosimetry codes of practice and guidelines for radiation measurements in radiotherapy, diagnostic radiology and nuclear medicine
- Project F4.04: Medical physics developments for quality assurance and clinical applications of ionizing radiation.

This arrangement was constructed to allow projects F4.01 and F4.02 to ensure the quality of the dosimetric chain and to enhance the capabilities of Member States to achieve and maintain high quality and consistency in their radiation measurements and dosimetry standards. F4.03 and F4.04 were intended to strengthen and harmonize calibration capabilities in Member States, and enhance their abilities to develop new techniques, methodologies, and training materials for dose auditing and quality assurance. An illustration of the arrangement of these major projects appears in Figure 1, reproduced here from page 6 of the DMRP report.

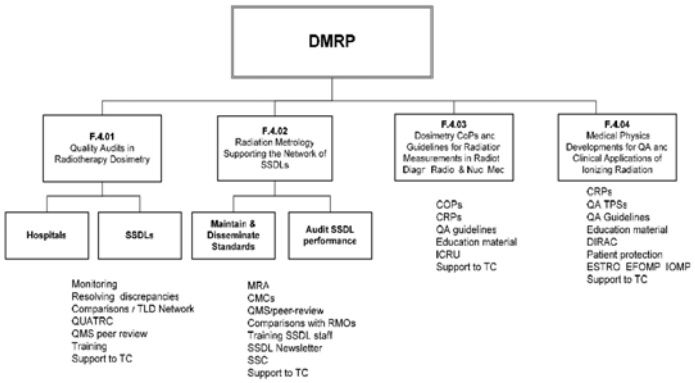

Figure 1: Overview of the major projects of the IAEA DMRP Subprogramme, 2006–2007

During the biennium 2008–2009, the numbering style has changed and all of the DMRP Section's projects and their titles begin with the designation 2.2.4 in place of F4, with some redistribution of the work activities:

- Recurrent Project 2.2.4.1: Quality audits in dosimetry for radiation medicine
- Recurrent Project 2.2.4.2: Radiation metrology supporting the network of Secondary Standards Dosimetry Laboratories
- Project 2.2.4.3: Quality assurance and guidelines for medical physics in the optimization of clinical radiation imaging
- Project 2.2.4.4: Quality assurance and medical physics developments in radiotherapy and therapeutic nuclear medicine

The SSC-13 report begins with a general discussion of administrative items and collaborative efforts within the IAEA. Selected projects are then discussed in turn. The report mentions only those particular activities of the DMRP Section for which the SSC has comments or recommendations at this time. No mention of a particular DMRP activity should be interpreted positively, as concurrence by the SSC with the activity as described in the DMRP Report.

3. REPORT

3.1 General Organizational Items

The SSC-13 was pleased to see that almost all of the recommendations of the SSC-12 have been implemented or are in progress and congratulates the IAEA on the strengths of its DMRP Section for achieving this. As before, the SSC has observed that the success of the DMRP encourages both Member States and other sections of the IAEA to demand more assistance from the DMRP. A continuation in this trend could overload the DMRP resources and jeopardize the quality of the services. The SSC-13 has made several recommendations that address the section's workload. However, the SSC-13 noted that the turnover in staff and delays in recruiting were placing a burden on the DMRP and limiting its possibility to achieve various targets. The SSC-13 encourages the IAEA to facilitate the replacement of vacant posts to avoid introducing delays into the projects that are strongly supported by the Member States. Although the SSC-13 was naturally disappointed that the earlier plan to establish a radioactivity measurements laboratory had been abandoned, it noted that the IAEA would purchase the expertise in this area, and consider collaboration with the BIPM and the NMIs to provide radioactivity standards. The SSC-13 was pleased to note that the IAEA had handled this issue appropriately and creatively.

The SSC-12 had recommended that a dosimetry symposium be held in 2008, to follow the 2002 symposium. The SSC-13 is naturally disappointed that the symposium will be delayed but was encouraged to learn that a Technical Meeting is planned for 2009 and the dosimetry symposium is tentatively scheduled to be held in 2010.

3.1.1 Recognition of medical physicists in the revision of the BSS

SSC-13 is pleased to see that the DMRP has made important contributions to revisions of the BSS. The SSC-13 encourages the DMRP to continue to play an active role in revisions to the BSS and ensure as far as possible that education and training aspects are included and supported for medical physicists in Member States.

3.1.2 Impact on Member States

The SSC-13 noted that the Programme of Action for Cancer Treatment (PACT) highlights the growing need for cancer care in Member States, the concomitant requirements in radiation medicine for appropriate diagnosis and therapy, and the increasing complexity of radiation equipment and treatment techniques that, without the appropriate professional support, are likely to lead to an increase in the number of incorrect administrations of radiation dose to patients.

1. To avoid an increase in the number of incorrect administrations of radiation dose to patients, the SSC-13 recommends that a resolution be prepared for the IAEA Board to urge Member States to establish audit mechanisms for radiotherapy using the QUATRO, methodology.

3.1.3 Facilities at the Dosimetry Laboratory (DOL)

The report from SSC-12 commended the success of the IAEA in the timely construction of the new radiation bunkers for radiation dosimetry and noted that this was achieved within the budget allocated.

The SSC-13 members likewise were pleased to see firsthand the new bunker and to note that a cobalt unit and a measurement cart have been installed. The SSC commends the DMRP for their continuing adaptation during the last two years to conform with the develop-

ing requirements from the IAEA Regulator for the safety of radiation sources used in DOL, including that in the new bunker. They were also pleased to learn that the authorization of the Regulator has recently been obtained, and that the calibration services and training for member states in the new facility can now commence.

The structure of the DOL, however, incorporates a matrix management system with the programmatic responsibility for its activities residing with the Section Head, DMRP, NAHU, while the responsibility for matters concerning administration, site operation and radiation safety is the purview of the Section Head, PCI, NAAL. This is explained in Figure 2, reproduced here from page 8 of the DMRP report.

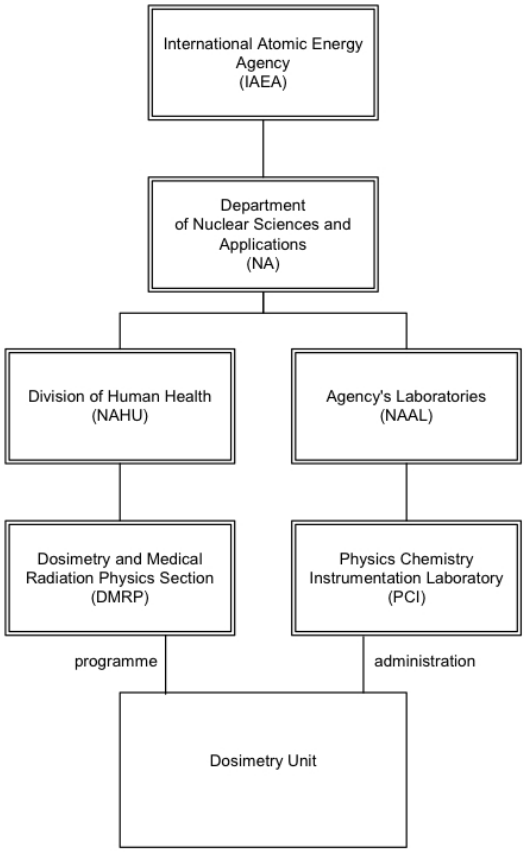

Fig 2: The placement of the Dosimetry Unit within the IAEA administrative structure.

During the deliberations of SSC-13, Mr. Andreo observed that the existing organizational structure is somewhat cumbersome. However, he also mentioned that progress had been made in improving the lines of communication, although there was still more work to be done in this area.

2. The SSC-13 is encouraged by the developments regarding the organizational structure at NAHU-NAAL and recommends that the chain of command and responsibilities be clarified and streamlined.

3.1.4 Timing of the DOL audit

Although the DMRP had attempted to hold the laboratory audit at Seibersdorf in advance of the SSC-13 meeting, the auditors were not available. As both the auditors are members of the SSC-13, they had to be excused from a significant part of the meeting to conduct the audit. This inevitably reduced the efficiency of the SSC-13 meeting, which was already short in persons present and so contributed to the delay in refining the SSC-13 recommendations and report.

3. The SSC recommends that auditors are chosen so that the audit of the DOL be conducted in advance of the SSC and as has proved satisfactory in the past, that documentation should be provided to the auditors in advance of the audit visit.

The SSC-13 heard the results from a recent satisfaction survey conducted of the SSDLs by the DMRP. A 50% response rate was achieved with no dissatisfaction expressed by the SSDLs, which the SSC feels is highly commendable. This satisfaction survey, required under ISO 17025 for the DOL quality system provides valuable feedback that is helpful to the DOL auditors.

4. The SSC-13 recommends that the DMRP conducts a satisfaction survey every 4 years, timed to have the results before scheduled audits of the DOL.

3.1.5 Collaboration within the Division of Human Health

The SSC-13 was pleased to see the increased level of collaboration among the subprogrammes within Human Health, and particularly noted the joint projects established between DMRP and the Sections of Applied Radiobiology and Radiotherapy (ARBR) and Nuclear Medicine. The SSC was also pleased to receive a document listing joint projects. The SSC believes that there are further opportunities for collaboration between DMRP and the Section of Nutrition, particularly regarding the use of dual-energy X ray absorptiometry (DEXA).

3.2 Project 2.2.4.1: Quality Audits in Dosimetry for Radiation Medicine

3.2.1 IAEA/WHO TLD Postal Dose Quality Audit Service for External Radiotherapy

The TLD audit service for external beam radiotherapy has operated now for 39 years. This is a popular and valuable service that is gaining visibility. As more hospitals in Member States offer radiation therapy, and particularly as hospitals introduce advanced technology treatments, the IAEA is likely to experience an increase in requests for this service. This increase could prove overwhelming to the DMRP and DOL staff, and affect their ability to respond to important needs, and possibly even the quality of work in other areas. Consequently, the SSC invites the IAEA to encourage Member States

that do not yet have national auditing groups, to establish such dosimetry audits. The SSC also believes it is essential that the DMRP not decrease its focus on basic dosimetry issues, while supporting and encouraging the use of advanced technologies.

5. The SSC-13 recommends that the IAEA considers encouraging the establishment of national dosimetry auditing groups in Member States that do not yet have these, as a direct response to the increasing number of requests for TLD measurements from their hospitals, to mitigate the increasing workload of the DMRP.

As more hospitals arrange for TLD monitoring from their national auditing groups, it is likely that these groups could institute QUATRO-type reactive audits to follow-up situations were TLD measurements indicate dosimetry problems. This will reduce the volume of work demanded of the DMRP and allow the IAEA to focus its efforts where the needs are greatest. It will also have the benefit of encouraging Member States to monitor and improve their treatment quality themselves. The SSC was pleased to see the development of procedures for comprehensive QUATRO audits and the mechanism for implementation following TC projects applicable in some regions. The SSC-13 proposes that for a future programme the DMRP pursue plans to gradually transfer QUATRO proactive audits to a national level so that countries can handle audits themselves.

The DMRP has reported receiving indications of interest from Member States in implementing (or expanding the use of) advanced treatment technologies such as intensity-modulated radiation therapy (IMRT) and stereotactic body radiation therapy (SBRT). The SSC is pleased to learn that the IAEA publication on transition from conventional 2D treatment to 3D conformal and IMRT is in press. This guidance document will be a great help to Member States with its step-by-step guidance for the implementation of IMRT. As a consequence, the IAEA should prepare for an increase in interest in the development of techniques to audit these advanced technologies using the TLD audit programme. Efforts should be made to encourage national TLD networks to take on more of this work.

The SSC-13 is pleased to see that the DMRP is implementing the CRP for auditing complex treatment techniques, particularly for IMRT and looks forward to the outcome as a report in 2012.

6. In the 2012-2013 programme, the IAEA should be aware that, having established audits for complex techniques, they can expect an increase in demand for the TLD audit service and should be prepared to meet this need in support of radiotherapy in the Member States.

3.2.2 The IDEA and the Quality Assurance System

The IAEA maintains the International Dose External Audits (IDEA) database, in which they store the TLD postal dose audits for hospitals. Maintaining the database assists the DMRP in tracking unacceptable results and their appropriate follow-up.

As part of the QA programme, the DMRP sends TLD to the BIPM, six PSDLs, several national TLD networks, and a few academic radiotherapy centres. Results from the BIPM and PSDLs are shown in Figure 3 where the results are for 60Co except as indicated.

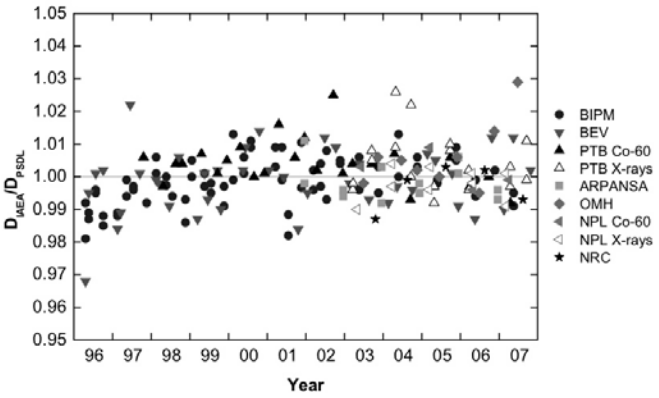

Figure 3: The results of reference TLD irradiations provided by the BIPM and six PSDLs during 1996-2007.

The 197 measurements shown in Fig. 3 have a mean of 1.000 and a standard deviation of 0.8%. None of the IAEA's measurements exceeded 3% difference from the doses stated by the reference laboratories. The data received during 2006-2007 (42 measurements) have a mean of 1.001 and a standard deviation also of 0.8%, demonstrating that the programme has remained stable.

The TLD measurements from several national TLD networks and a few academic radiotherapy centres are shown in Figure 4.

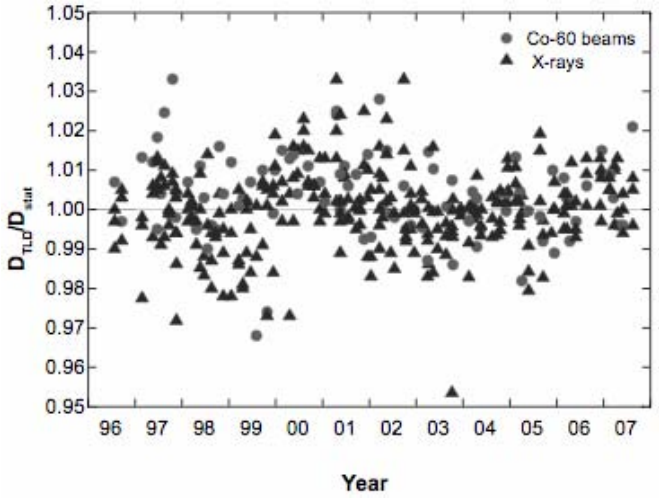

Figure 4: TLD measurements provided by several national TLD networks and a few major academic radiotherapy centres.

The data in Fig. 4 indicate a mean value of 1.001 and a standard deviation of 1.0%. All but one of the data points fall within a range of about 3% from unity. The

data acquired during the 2006-2007 biennium show a mean of 1.002 and a standard deviation of 0.9%.

The SSC was pleased to see the development and implementation of an electronic form for submission of TLD data. It is hoped that the availability of the online form will improve the rate at which institutions submit complete data in the future.

Results of irradiations by hospitals

In a typical year, the DMRP measures the output of over 400 beams. This number has increased over previous years thanks to the institution of automated TLD procedures a number of years ago, and the development of an electronic data-entry system in more recent years. During the past 39 years, the programme has verified the calibration of 6845 photon beams in 1570 hospitals. A graph showing the results received during 2006-2007 is shown in Figure 5.

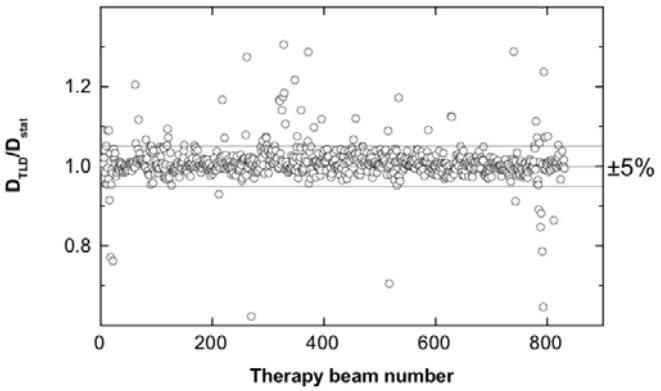

Figure 5: Results of the 2006-2007 postal TLD audits of radiotherapy facilities.

Figure 5 shows that approximately 8% of the measurements fall outside the IAEA's ±5% acceptance limits. This is a significant improvement over past years where for example in 1995, 18% of the measurements fell outside these criteria.

The SSC-13 encourages the DMRP to consider the best mechanism for helping those member states that produce poor dosimetry results because of their equipment, as identified through TLD audit or ion chamber comparison, to upgrade their metrology and treatment equipment to modern standards perhaps through TC mechanisms.

The IAEA has already experienced success in moving institutions from the IAEA's TLD audit system to networks operated by national TLD services. To quantify the effectiveness of such services, it will be valuable for the IAEA to identify the extent to which the national services are actually used.

7. SSC-13 recommends that a method of systematic reporting on the number of beams audited by the National TLD networks be identified to determine the extent of dissemination of radiotherapy audits.

3.2.3 The IAEA's focus on radiotherapy audits

The SSC-13 recognizes that the DMRP is eager to provide a variety of services to Member States, and indeed there is a demand for increasing support, particularly for advanced technologies in imaging and radiotherapy. However, the DMRP should be cautious to avoid diluting its activities in radiotherapy while striving to meet the demands for new services.

8. When considering demands from the Member States in pursuing various projects, SSC-13 recommends that the IAEA continues to place the highest priority on radiotherapy dosimetry and audits, particularly for developing countries.

3.3 Recurrent Project 2.2.4.2: Radiation Metrology supporting the Network of Secondary Standards Dosimetry Laboratories (SSDLs)

The IAEA and the WHO operate the SSDL network jointly, although the IAEA is responsible for technical developments at the member laboratories. The SSDL network now consists of 81 calibration laboratories and 6 SSDL national organizations in 68 Member States. More than half of these are in developing countries. The BIPM, several PSDLs, the ICRU, and several other international organizations are affiliate members and provide support to the SSDL network. The DMRP closely monitors the performance of the SSDLs, and ensures that they comply with measurement and reporting requirements.

3.3.1 Membership in the SSDL Network

In response to a recommendation by SSC-12, two members have been removed from the network. At the same time, four new members have joined. In addition, two SSDLs have been identified as regional centres under the SSDL programme. These two SSDLs serve communities outside their national borders, and also will provide training for IAEA fellows to learn calibration procedures.

It was noted that the adoption of advanced radiotherapy and imaging techniques in many Member States has prompted some SSDLs to add new measurement capabilities.

3.3.2 Monitoring of SSDL Measurements in Radiotherapy

Data from SSDL annual reports indicate that SSDLs traceable to the IAEA disseminated to their end-users 536 instruments calibrated for radiotherapy, 10,827 instruments calibrated for radiation protection (including diagnostic radiology), 36,469 calibrated individual personal dosimeters, and performed 125 on-site calibrations.

These SSDLs also conducted TLD audits of 480 radiotherapy beams, and recommended improvements in dosimetry at 32 institutions. These improvements were confirmed during follow-up visits, assuring that patient care was in fact improved at these institutions.

The SSC-13 wishes to record its pleasure with this satisfactory take-up and dissemination of the DMRP's work in Member States.

Indeed, the IAEA provides calibrations to many of the SSDLs whose instruments are sent to the Agency's Seibersdorf laboratories. However, the SSDLs in some countries experience difficulties with their customs officials, and their instruments are often delayed on their way out of or back into their countries. To overcome these difficulties the IAEA is increasingly making use of the UNDP whereby an instrument is sent from the IAEA to the UNDP and then to the SSDL.

9. In view of the difficulty of some Member States to transport their dosimetry standards to the IAEA, the SSC-13 recommends that the DMRP encourage the use of TC projects for visiting scientists to enable the SSDL staff to bring their instruments to the IAEA for calibration and indeed take part in the set up procedures as part of knowledge transfer.

Similar problems are also delaying and sometimes even preventing the verification by the IAEA of the SSDL's dissemination of their national standard. This verification is achieved by the SSDL calibrating a transfer instrument and sending it to the IAEA for them to verify the calibration by comparison with their own IAEA result. However, some SSDLs, with a lack of suitable transfer instruments are understandably reluctant to submit their national standard to potential delays and possible loss/damage during transport. This problem could be solved if the IAEA provided the transfer instruments for this purpose.

10. In view of the difficulty of some SSDLs in taking part in dosimetry comparisons, using ion chambers, with the IAEA, the SSC-13 recommends that the Agency acquires appropriate ionization chamber transfer standards to be used by the DMRP for comparisons with SSDLs to enable the latter to comply with the requirements of the IAEA/WHO SSDL Charter.

During the 2006-2007 biennium, the IAEA verified the dissemination of calibration standards by eight SSDLs. The results of these instrument comparisons are shown in Figure 6. The results show agreement of the SSDLs with the IAEA within 1.5% for measurements of air kerma and absorbed dose.

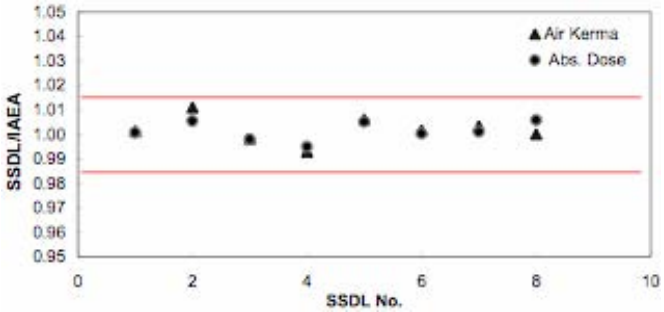

Figure 6. Ratios of the calibration coefficients assigned by 8 SSDLs to those measured by the IAEA. All of the rations are within ±1.5%.

The IAEA/WHO TLD postal dose audit service has monitored the performance of the SSDLs in the radiotherapy dose range since 1981. In that time period, 885 beam calibrations were checked at 68 SSDLs, including measurements in both cobalt and X ray beams. Some 3% of the measurements fell outside the IAEA's 3.5% acceptance level and these were followed up with a satisfactory final outcome. Figure 7 shows the results of the TLD monitoring of SSDLs.

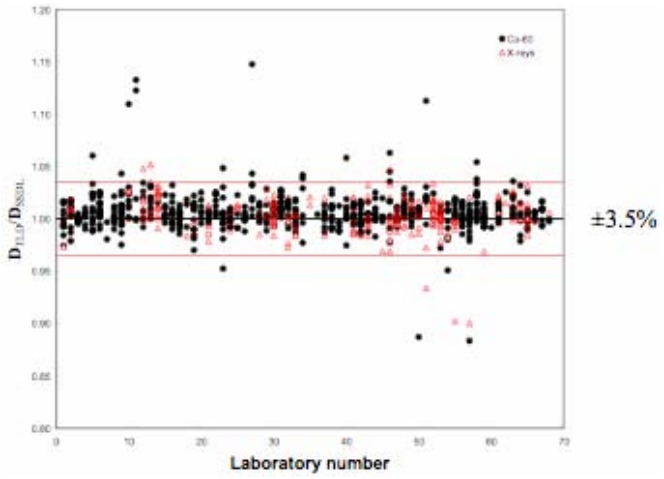

Figure 7. Results of the IAEA/WHO TLD audits 1997–2007 (radiotherapy level). Ratios of the dose determined by the IAEA from TLDs irradiated by the SSDLs, to the dose stated by the SSDLs.

3.3.3 Monitoring of other SSDL measurements

The IAEA also uses a TLD audit system to evaluate the performance of the SSDLs at the radiation protection level. In response to a recommendation from SSC-12, the IAEA has increased the acceptance level for radiation protection measurements to ±7%. No audit was conducted in 2006 due to a vacancy at the DOL, but in 2007 an audit of 14 SSDLs was performed. The results are shown in Figure 8.

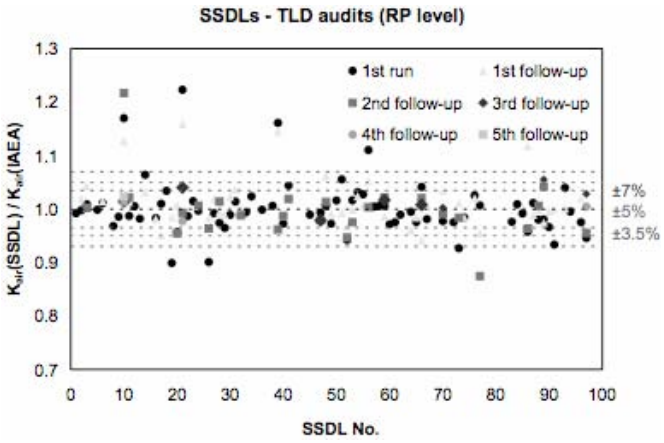

Figure 8. Ratio of the air kerma stated by the SSDLs to that measured by the IAEA using the TLD audit programme. The graph shows data at radiation protection levels accumulated since the inception of the programme in 1999.

During 2007, only one SSDL's measurement fell outside the 7% criterion. A repeat measurement at this laboratory fell within the acceptance criterion.

The IAEA's publication on the calibration of radiation protection monitoring instruments (Safety Series No. 16) is now outdated. A revision in collaboration with Nuclear Safety would be timely.

11. The SSC-13 recommends that the IAEA should consider updating its guidance on recommendations for the calibration of radiation protection monitoring instruments.

The SSC-13 congratulates the DMRP for producing electronic reporting forms for the IAEA/WHO SSDL Network, to facilitate the submission of annual reports. The report form can also be modified in the future to include more data that would allow the DMRP to better determine compliance with the recommended quality assurance procedures.

12. The SSC-13 recommends that the SSDL electronic reporting form contain a specific request relating to the number and dates of comparisons that the SSDL has made with the IAEA or Regional Metrology Organization to identify this aspect of conformity with the SSDL Network Charter.

13. In view of the changes that have taken place over the last 10 years in international metrology, the SSC-13 recommends that the IAEA/WHO SSDL charter be reviewed to take into account the developments resulting from the CIPM MRA, new radiation medicine technologies and associated developments in ionizing radiation metrology.

The SSC-13 was pleased to see that the CRP on the diagnostic X ray code of practice has resulted in the publication and dissemination of the code and looks forward to news of its implementation by Member States. The SSC-13 is pleased to learn that the DMRP is acquiring a kerma-area-product (KAP) meter with a view towards helping train member states in applying the code of practice in calibrating KAP instruments.

The DMRP has invested considerable effort into installing and commissioning updated diagnostic X ray dosimetry irradiation facilities including a mammographic X ray unit at the IAEA's laboratories in Seibersdorf. This will ensure robust calibrations for the SSDLs, and in particular for calibrations of mammographic dosimetry equipment. Several investigations will be needed to produce adequate uncertainty budgets for X ray calibrations.

14. The SSC-13 recommends that the DMRP investigate the effects of different calibration distances for mammography in terms of the influence on the uncertainty budget before setting a reference distance for future calibrations.

15. The SSC-13 recommends that aspects of uncertainty associated with the new diagnostic set ups, particularly for the calibration of CT chambers and KAP meters – under various methods or geometries are investigated.

The SSC-13 notes that a recommendation made by SSC-12 advised the DMRP to submit its dosimetry CMCs to the JCRB for review. The SSC-13 was pleased to note that the Agencies revised CMCs have been published and that its Quality System has been reviewed and approved by the JCRB and the CIPM. The SSC-13 encourages the IAEA, as it is outside the RMO communication system, to keep a watching brief on the documents of the JCRB to ensure its continued compliance with the CIPM MRA and the production of its brief annual report to the JCRB.

3.4 Project 2.2.4.3: Quality Assurance and Guidelines for Medical Physics in the Optimization of Clinical Radiation Imaging

A consultants' meeting was held in 2007 regarding the use of imaging in radiotherapy. The meeting produced the following recommendations that are reproduced here to reiterate their importance.

- The IAEA should recognize and support the pivotal and pervasive role of imaging in the radiation therapy process.
- The IAEA should facilitate appropriate training in imaging in radiotherapy for radiation oncology professionals in member states.
- The IAEA should provide guidance documents on the appropriate use of imaging in the design and delivery of radiation therapy.
- The IAEA should participate in defining and promoting methods for assuring QA. Should design an end-to-end phantom to evaluate imaging and treatment.

- The IAEA should collaborate with other groups working in this area.

16. The SSC-13 recommends that the DMRP collaborate with ARBR and the NMS on the recommendations coming out of the report of the consultants' meeting on imaging in radiotherapy. The outcome of this collaboration should be incorporated into common DMRP/ARBR and DMRP/NMS activities.

17. The SSC-13 recommends that DMRP support the ARBR and the NMS in their development of training programmes to address imaging in radiotherapy for radiation oncology professionals in member states, as recommended by the consultants' report that will appear on the IAEA web.

Following the successful publication and subsequent extensive distribution and adoption of the Handbook on radiotherapy physics, the SSC was pleased that the DMRP is now working on developing similar handbooks on diagnostic radiology and nuclear medicine physics. The SSC-13 encourages the DMRP to continue development of the handbooks. These materials should not overlook the important role that imaging plays in radiotherapy. The SSC also encourages the DMRP to continue with plans to develop materials for physics training at the masters' level.

The Handbook on radiotherapy physics and the training materials currently in development are likely to be widely adopted and should lead to stronger training programmes and greater uniformity of training of medical physicists.

18. The SSC-13 recommends that the IAEA promotes the harmonization of training programmes in developing countries by supporting requests for TC projects and by disseminating the handbook produced on radiation oncology physics and in due course those being produced for diagnostic radiology and nuclear medicine.

The SSC-13 was pleased to be informed about the goals to develop basic QA/QC guideline documents in diagnostic radiology and nuclear medicine. The QA documents on SPECT systems and in PET/CT systems should be published during 2008 and the guidelines on quantitative nuclear medicine imaging will be prepared in 2009. Further documents are planned during 2010-2011. The SSC-13 agrees with and supports the DMRP's focus on education in diagnostic radiology and nuclear medicine to complement the existing educational projects in radiotherapy. The SSC-13 congratulates the DMRP on the plans to publish QA/QC procedures for diagnostic radiology and nuclear medicine and strongly supports the development of a CRP to promulgate the guidelines for their implementation by Member States.

The SSC-12 supported a CRP on developing procedures for dosimetry auditing in diagnostic radiology by the SSDLs. The SSC-12 also recommended that the CRP focus on procedures with potential for high doses, such as fluoroscopy, CT, computed radiography, and digital imaging procedures in which increased doses can be delivered inadvertently, and on other procedures where consistency with current practice involves the coupling of image quality to dose. The SSC-13 understands that a Consultants' meeting recommended the immediate development of a comprehensive clinical audit methodology, along the same concept as QUATRO. This audit tool would use the dosimetry standards and phantoms specified in the new TRS-457 to address concerns of dosimetric practice in clinical sites. This concern is in the first instance for procedures that are complex and of high risk, i.e. mammography, CT, interventional and paediatric.

19. The SSC-13 recommends that comprehensive clinical audits, similar in concept to QUATRO, be developed for diagnostic imaging and nuclear medicine. Prioritization of auditing should be on developing a QC culture, and image quality aspects particularly for complex and high-risk procedures, including CT, nuclear medicine and paediatrics.

The SSC-13 encourages the IAEA to consider developing a simple combined phantom system that can be used for evaluating image quality and dose from different imaging procedures in a manner that is consistent with the CoP on diagnostics.

20. Bearing in mind the need for direct measurements of diagnostic X ray doses, the SSC-13 recommends that the IAEA supports the development of a CRP regarding the calibration of KAP meters.

The SSC-13 understands that the WHO is proposing a trial of digital imaging and teleradiology in member states. It would be valuable for the IAEA to participate in developing the QA and training materials for this trial.

21. The SSC-13 recommends that the DMRP collaborate with the WHO in updating existing dosimetry and basic imaging QA procedures and corresponding training materials for use in developing countries.

The SSC-13 encourages the DMRP to work on QC protocols for the digital aspects of imaging.

3.5 Project 2.2.4.4: Quality Assurance and Medical Physics Developments in Radiotherapy and Therapeutic Nuclear Medicine

3.5.1 External dosimetry and publications

The IAEA's TLD and SSDL database revealed that 42 Member States make use of the IAEA's calibration protocol for radiotherapy published in TRS-398. Feedback from the DMRP's workshops indicates that 39 Member States are using IAEA-TECDOC-1540 on Selection and Acceptance Testing of Treatment Planning Systems. Finally, 15 Member States are already using the handbook on Radiation Oncology Physics in their programmes. This publication was the second best seller (following the IAEA History book) last year. The SSC-13 anticipates that the teaching material to accompany the book will be received with enthusiasm by the Member States.

The SSC-13 was pleased to hear that the DMRP is planning to prepare an update of TRS-398, and that the update of TRS-374 is almost complete. The DMRP is working to encourage the adoption of the dose-to-water calibration protocol, and the SSC strongly supports these efforts.

The IAEA has previously published IAEA-TECDOC-1274 on Calibration of Photon and Beta-Ray Sources used in Brachytherapy. It has been determined that a user unfamiliar with the energy dependence of the measuring equipment could apply the provisions of this calibration protocol incorrectly and introduce errors into the calibration of brachytherapy sources. Inconsistencies in dose delivery from one treatment centre to another could result.

22. In view of the fact that incorrect implementation of IAEA-TECDOC-1274 may lead to incorrect calibrations for energy-dependent chambers, the SSC-13 recommends that the DMRP proceed with the revision of this brachytherapy guidance document and develop a code of practice for Member States to use for the consistency of calibrations for HDR brachytherapy.

3.5.2 New techniques

The SSC-13 heard during presentations by the DMRP staff that member states are showing increasing interest in advanced technologies in radiotherapy, including 3D conformal radiotherapy (3DCRT) and intensity-modulated radiation therapy (IMRT). These are complex technologies and mistakes made during their introduction can lead to serious treatment errors. SSC-13 was very pleased to see that IAEA-TECDOC-1595 will be published as this will be an important document for assisting member states to implement 3DCRT and IMRT.

23. The SSC recommends that the DMRP give high priority to the development of quality assurance and training materials to support the member states in preparing for the transition to conformal 3D radiotherapy and to IMRT, and that the QA methodology for advanced modalities be incorporated into the QUATRO programme.

The SSC-13 notes that DMRP has an activity to provide scientific and technical contributions to national and regional TC projects related to QA and medical physics in radiation medicine, and to PACT. This is an important activity and should continue.

The SSC-13 understands that the doctoral CRP that was developed on advanced technologies in radiotherapy has been pushed into 2008, and will have to be extended. This is important work and the SSC encourages the DMRP to ensure that the CRP is completed in a timely fashion.

The SSC-13 encourages the DMRP in the implementation of doctoral CRPs to increase the medical radiation physics research capability in Member States.

The SSC-13 recognizes that SSC-12 recommendation 30 to hold a CRP on treatment of non Hodgkins lymphoma with radiopharmaceuticals was too ambitious. The SSC-13 concurs with the DMRP that it would be better to address this through a CM.

Finally, the SSC advises the DMRP to keep a close watch on the development of proton and ion beams in Member States and consider ways in which the IAEA can support the accuracy and safety of patient treatments with these beams.

3.5.3 Accuracy requirements in radiotherapy

The SSC-13 was pleased to note that a consultants meeting is scheduled for 2008 to develop guidelines for accuracy requirements and uncertainties in dosimetry for radiotherapy. This is important work and is being pursued through collaboration with ARBR.

24. The SSC-13 recommends that the IAEA supports the development of a guidance document addressing accuracy requirements in radiotherapy, together with ARBR.

3.5.4 In Vivo Dosimetry

The SSC-13 was pleased to hear that a DMRP CRP directed toward the development of in-vivo dosimetry is approaching completion. The SSC also notes that the measurement procedures of in-vivo dosimetry are often complicated and awaits the outcome of the CRP with interest.

The SSC-13 encourages the DMRP to send a copy of the IAEA-TECDOC on the results of the CRP on *in-vivo* dosimetry to each hospital taking part in the audits so as to share their experiences of *in-vivo* dosimetry and enable the IAEA to identify their developing needs.

3.5.5 Small fields

The SSC-13 notes that guidelines are being developed for measurements in small and irregular treatment fields and that this is an important issue. The SSC looks forward to seeing the outcome in the 2010-2011 biennium.

3.5.6 DIRAC

The SSC-13 was particularly pleased with the significant improvements to the DIRAC data base that has been achieved, especially through the on-line participation and verification by the Member States. However, during its presentation on the DIRAC, the DMRP staff noted that the collection of data has been hampered by the reluctance of some facilities to submit their data, believing it to be confidential. The SSC believes that the DIRAC is an important and valuable resource and that strategies should be found to encourage facilities and Member States to provide their data. The SSC is pleased that the DMRP is able to keep DIRAC available on line, and has overcome the concerns about security. The SSC trusts that the database will continue to be available on line. Its contents have already been referenced by the BIPM and the WHO.

25. The SSC-13 recommends that during the 2010-2011 biennium, the IAEA invite the WHO to write to ministers of health in the Member States to give their authority to inclusion of their country-specific information in the DIRAC database and consequently confidence to the participating hospitals in the ownership, security, and use of this information. The DMRP should also consider, together with the WHO, additional ways of highlighting the collaboration with the WHO in this project.

In view of the need to identify appropriate levels of diagnostic imaging support to developing countries, the SSC-13 encourages the co-secretariats of the IAEA/WHO SSDL network to consider an international collaboration for a diagnostic imaging equipment database with resources for this identified by the WHO.

3.5.7 Internal dosimetry

The SSC-13 heard about the DMRP's work in internal dosimetry in nuclear medicine and radionuclide therapy. These projects fall under both Project 2.2.4.3 (Quality Assurance and Guidelines for Medical Physics in the Optimization of Clinical Radiation Imaging) and Project 2.2.4.4 (Quality Assurance and Medical Physics Developments in Radiotherapy and Therapeutic Nuclear Medicine). The SSC believes that internal dosimetry is an important function and that development work should be continued.

26. The SSC recommends that the IAEA identify appropriate internal dosimetry techniques for nuclear medicine, including quantitative nuclear imaging, to support the development of international guidelines for optimized targeted radionuclide therapy, in conjunction with the Nuclear Medicine subprogramme.

Acronyms used in the SSC-13 Report

3-D	3-dimensional
ARBR	Applied Radiation Biology and Radiotherapy Section of the IAEA
BIPM	Bureau International des Poids et Mesures
BSS	Basic Safety Standards (refers to « International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources », IAEA publication No. 115 in the Safety Series)
CIPM	International Committee of Weights and Measures (BIPM)
CM	Consultants' meeting of the IAEA
CMC	Calibration and Measurement Capability
CoP	Code of Practice
CRP	Coordinated Research Project of the IAEA
CT	Computed tomography
DG	Director General (of the IAEA)
DIRAC	Directory of Radiotherapy Centres
DMRP	Dosimetry and Medical Radiation Physics Section of the IAEA
DOL	IAEA's Dosimetry Laboratory
ESR	Electron spin resonance
ESTRO	European Society for Therapeutic Radiology and Oncology
EUROMET	European Collaboration in Measurement Standards
HDR	High dose rate
IAEA	International Atomic Energy IAEA
ICRU	International Commission on Radiation Units and Measurements
IDAS	International Dose Assurance Service
IEC	International Electrotechnical Commission
ILO	International Labour Office
IMRT	Intensity modulated radiation therapy
IOMP	International Organization for Medical Physics
ISO	International Organization for Standardization
JCRB	Joint Committee of Regional Metrology Organizations and the BIPM
MPIT	Medical Physics Investigation Team of the IAEA
MRA	Mutual Recognition Arrangement
MRI	Magnetic resonance imaging
NAAL	IAEA's Laboratories Division, Vienna and Seibersdorf
NAHU	Division of Human Health of the IAEA
NIST	National Institute of Standards and Technology (USA)
NMS	Nuclear Medicine Subprogramme
OECD	Organisation for Economic Cooperation and Development
OIOS	Office of Internal Oversight Services of the IAEA
PACT	Programme of Action for Cancer Therapy of the IAEA
PET/CT	Positron Emission Tomography/Computed Tomography
PSDL	Primary Standards Dosimetry Laboratory
QA	Quality assurance
QANTRM	The IAEA's International Conference on Quality Assurance and New Techniques in Radiation Medicine, to be held 13-15 November 2006
QMS	Quality management system
QS	Quality system
QUATRO	Quality Assurance Team for Radiation Oncology
RMO	Regional Metrology Organization
SSC	SSDL Scientific Committee
SSDL	Secondary Standards Dosimetry Laboratory
TC	Department of Technical Cooperation of the IAEA
TL	Thermoluminescent, or thermoluminescence
TLD	Thermoluminescent dosimeter, or thermoluminescence dosimetry
TPS	Treatment Planning System
TRS	Technical Reports Series (an IAEA publication series)
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WHO	World Health Organization

Audit of Secondary Standard Dosimetry Laboratories

A guide for SSDLs and IAEA audit teams

Report of a Consultants' Meeting

IAEA, Vienna
7-10 July 2008

FOREWORD

The need for international traceability for radiation dose measurements has been understood since the early nineteen-sixties. The benefits of high dosimetric accuracy were recognized, particularly in radiotherapy, where the outcome of treatments is dependent on the radiation dose delivered to patients. When considering radiation protection dosimetry, the uncertainty may be greater than for therapy, but proper traceability of the measurements is no less important.

To ensure harmonization and consistency in radiation measurements, the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO) created a Network of Secondary Standards Dosimetry Laboratories (SSDLs) in 1976. An SSDL is a laboratory that has been designated by the competent national authorities to undertake the duty of providing the necessary link in the traceability chain of radiation dosimetry to the international measurement system (SI, for Système International) for radiation metrology users. The role of the SSDLs are crucial in providing traceable calibrations; they disseminate calibrations at specific radiation qualities appropriate for the use of radiation measuring instruments. Historically, the first SSDLs were established mainly to provide radiotherapy level calibrations, however the scope of their work has been expanded over the years. Today, many SSDLs provide traceability for radiation protection measurements and diagnostic radiology in addition to radiotherapy. Some SSDLs, with the appropriate facilities and expertise, also conduct quality audits of the clinical use of the calibrated dosimeters — for example, by providing postal dosimeters for dose comparisons for medical institutions, or on-site dosimetry audits with an ion chamber and other appropriate equipment.

The requirements for traceable and reliable calibrations are becoming more important. For example, for international trade where radiation products are manufactured within strict quality control systems, and it is necessary that they conform to given safety and performance criteria. The demonstration of the competence of calibration laboratories is achieved through comparisons and the establishment of a quality management system following the International Standards Organization (ISO) standard 17025.

Through its Technical Cooperation (TC) Programme, the IAEA has a long history of providing assistance for the establishment and/or upgrading of SSDLs. However, there are still many countries with no calibration facilities. The IAEA, through its dosimetry laboratory in Seibersdorf, provides calibration services to SSDLs. In exceptional situations, the IAEA has provided calibration services to hospitals in countries with no SSDLs. However, the IAEA cannot respond timely to all calibration requests submitted by hospitals or radiation protection institutions. Therefore, the concept of Regional Designated Centres (RDCs) in the field of calibrations and dosimetry was developed within the TC Programme to assist Member States develop regional capabilities in the field of calibration in radiation dosimetry. Before such RDCs are nominated through the regional agreements, it is necessary to assess their calibration and measurement capabilities through well structured audits.

The IAEA invited a team of specialists in radiation metrology consisting of: A.H.L. Aalbers (Netherlands), I Csete (Hungary), K.C. De Souza Patrao (Brazil), Z.L.M. Nsimang (South Africa) and charged them with providing recommendations on the auditing methodology for SSDLs. The use of standardized procedures and check lists will help ensure consistency and harmonization in quality auditing of SSDLs. The full report with appendices will be posted on the IAEA web site and it will be also available from the section.

1. INTRODUCTION

The delivery of reliable calibrations requires well-trained staff, suitable equipment and adequate resources. There is a growing international consensus that a formal quality management system can benefit both the calibration laboratory and its customers. In general, a Quality Management System (QMS) consists of a documented set of procedures, instructions and tem-

plates. Most Secondary Standards Dosimetry Laboratories (SSDLs) will already have some system in place for assuring quality, although it might not be formally documented, nor correspond to the requirements of a modern management system. The purpose of a QMS in a calibration laboratory is to maintain, and where possible improve, the reliability of calibrations. The documentation should be seen as a tool to achieve this purpose, not the purpose itself. For the SSDL, documented calibration procedures reduce the likelihood of error following a change in staff. For the user, there is an additional confidence in the results received from an SSDL if it is known that they have the QMS in place. An important element of a successful quality management system is its regular review to identify possible areas for improvement. Independent external audits are a necessary part of the QMS.

The requirements that must be fulfilled by an SSDL are clearly given in the IAEA/WHO SSDL Network Charter [1] and the ISO/IEC 17025 standard [2]. The national accreditation bodies and international organizations (e.g. regional metrology organizations) play an essential role in providing confidence in the laboratory QMS by assuring that the laboratories constantly fulfil the criteria as embodied by international standards. This assurance can be achieved through a mechanism of periodic surveillance activities, including (re)assessment visits. These accreditation bodies and international organizations have developed and use harmonized guidelines for conducting laboratory assessment. The audit methodology developed in this publication is based on similar principles and presents a guideline for the SSDLs co-operating in the IAEA/WHO network.

1.1 Background to IAEA activities in calibration and auditing of SSDLs

The IAEA's technical cooperation programme has played an important role in the establishment of many of the SSDLs which now form the IAEA/WHO Network. Its assistance has ranged from small projects involving one or two months of expert advice, to large-scale projects in which the IAEA has provided, over a period of several years, major basic equipment for use in an SSDL (including irradiation facilities, radiation safety installations and dosimetry equipment), and training for staff. Additionally, co-ordinated research projects covering a wide range of topics related to radiation metrology and quality assurance procedures have been organized with the participation of many SSDLs.

The IAEA, through its dosimetry laboratory in Seibersdorf, provides calibration services to SSDLs. In exceptional situations, the IAEA has provided calibration services to hospitals in countries with no SSDLs. However, the IAEA cannot respond timely to all calibration requests submitted by hospitals or radiation protection institutions. Therefore, the concept of Regional Designated Centres (RDCs) in the field of calibration and dosimetry was developed within the TC Programme to assist Member States develop regional capabilities in the field of calibration in radiation dosimetry. Before such RDCs are nominated through the regional agreements, it is necessary to assess their calibration and measurement capabilities through well structured audits. The objective of these audits is to review and evaluate the quality of all components of the calibration services.

1.2 Purpose of audits

An audit of an SSDL should review and evaluate the quality of all elements involved in calibration services, including personnel, equipment, procedures, safety, and overall performance of the laboratory, as well as its interaction with its customers and external service providers. Areas for improvement should be identified with a view of designating the appropriate SSDL as an RDC complying with the IAEA requirements.

SSDLs in Member States may request an audit for following purposes:

- For support in their application to become an RDC;
- To receive assistance in expanding the scope of its calibration services;
- To strengthen their quality assurance (QA) programme;
- To solicit funding from national authorities or other funding bodies including the IAEA.

This audit is not designed for:

- Regulatory purposes, i.e. the auditors are not convened as an enforcing tool but solely as an impartial source of advice on quality improvement;
- Investigation of a serious mistake in calibration. In the event of any serious mistake, a more focused audit is required.

1.3 Scope

This document specifies technical and management requirements for RDCs and gives guidance on their audit. It can be also used for auditing any SSDL from the IAEA/WHO Network of SSDLs. The audit structure is described giving details on its various steps, roles of SSDLs, auditors and the IAEA. Procedures describing the entrance briefing, the assessment itself, the exit briefing and the form of the report and its dissemination are also given. The extensive checklists will help the auditors to standardize the audit procedure and reporting back to the IAEA.

2. IAEA/WHO SSDL NETWORK and RDCs

In 1976, the IAEA and the World Health Organization (WHO) strengthened implementation of the SI in radiation dosimetry by setting up a network of SSDLs to ensure the traceability of measurements, particularly for countries that are not members of the Mètre Convention. As of January 2008, the SSDL network includes 76 laboratories and 6 SSDL national organizations in 64 IAEA Member States [3]. The SSDL network also includes 20 affiliated members, for example, the Bureau International des Poids et Mesures (BIPM), several Primary Standards Dosimetry Laboratories (PSDLs), the International Commission for Radiation Units and Measurements (ICRU), the International Organization of Medical Physics (IOMP) and several other international organizations.

2.1 Role of an SSDL

An SSDL is a laboratory that has been designated by competent national authorities to undertake the duties of providing the necessary link in the traceability of radiation dosimetry to national or international standards for users within that country. An SSDL is equipped with secondary standards traceable to a PSDL or BIPM directly or through the IAEA. The reference standards of about 50% of the SSDL Network members are traceable to the IAEA, 30% to PSDLs and the remainder to the BIPM. SSDLs provide traceable instrument calibrations to users. The scope of the calibrations provided by SSDLs covers a wide range of services: external radiotherapy, brachytherapy, diagnostic radiology including mammography, radiation protection and nuclear medicine. While some SSDLs offer the entire range of calibration services, others offer only one or two types of calibrations.

The main function of an SSDL is to provide calibration services, including the dissemination of information on calibration procedures, and practical help to users on instruments used in their particular application. Some SSDLs having the appropriate facilities and expertise can provide a range of additional services, such as:

1. Dosimetry comparisons for medical institutions within a country or region (using TLD, ion chambers or on-site visits).
2. Reference irradiations for personal radiation dosimeter services.
3. Advise to users on quality assurance matters.
4. National training courses in radiation measurement and calibration techniques and in the use and maintenance of the instrumentation.
5. Maintenance of measuring instruments for users.

2.2 Role of a Regional Designated Centre

The role of a regional designated centre is, in principle, similar to that of a national SSDL. Its main function is to provide calibration services and practical help to users on instrument use in their particular application in the region. In addition and upon request by Member States in the region, other services as listed in items 1-5 above could be offered.

3. REQUIREMENTS FOR A REGIONAL DESIGNATED CENTRE

3.1 Background

The concept of RDCs was developed aiming at assisting Member States to develop regional capabilities in the field of calibration in radiation dosimetry. This is important because the IAEA does not have a sufficient capacity to cover growing needs for calibration of radiation measurement instruments in various areas of application of ionizing radiation. To be able to provide calibration services, the laboratory infrastructure has to be developed so that it enables the RDC to provide services according to required regional demands. This concerns a laboratory layout, equipment, manpower, etc. The SSDLs have to fulfil certain criteria given in this section before they are nominated as RDCs.

3.2 Minimum requirements

1. To provide traceable calibration services and certificates in one or more of the following fields: external radiotherapy, brachytherapy, radiation protection, environmental level dosimetry, general diagnostic radiology; mammography (following IAEA/WHO charter [1] and ISO/IEC 17025 standard [2]). Traceability must be to a PSDL with the capabilities published in the BIPM CMC database or to the BIPM through the IAEA.
2. A comprehensive QMS should be in place which follows ISO/IEC 17025 standard [2].
3. Dissemination of traceability and demonstration of the appropriate calibration techniques using internationally accepted protocols/methods.
4. Laboratory is working in compliance with the requirements of the International Basic Safety Standards (BSS 115, [4]) and the country regulatory requirements.
5. Laboratories should have sufficient irradiation facilities and measurement equipment to provide for the services listed in 1.
6. SSDL staff should have qualifications and experience in measurement procedures and practices appropriate to their responsibilities.
7. The SSDL shall provide for continuous individual training for the SSDL staff

(Participation in workshops, regional dosimetry activities, participation in scientific work etc).

8. The SSDL shall participate in periodic measurement assurance tests with a frequency established by the IAEA/WHO SSDL Network Secretariat [1]. These tests include:
    - verification of radiation source calibration with TLD,
    - verification of the SSDL calibration procedure(s) with ionization chambers.
9. SSDL shall submit an annual report to the Network Secretariat according to the SSDL charter requirements [1] in the IAEA format.
10. The SSDL shall participate in comparison exercises (regional, international) to support their claim of measurement capabilities.
11. The SSDL shall have access to all the literature that they refer to in their procedures and policies.

3.3 Management requirements

1. An SSDL shall be a laboratory which has been designated by competent national authorities to undertake the duties of providing the necessary link in the traceability of radiation dosimetry to national/international standards for users within that country.
2. The laboratory or the organization of which it is part shall be an entity that can be held legally responsible
3. The laboratory shall establish, implement and maintain a quality management system following the management requirements including the organisational structure according to ISO/IEC 17025 [2].
4. The roles and responsibilities of technical management and the quality manager, including their responsibility for ensuring compliance with ISO/IEC 17025, shall be defined in the quality manual. In the case where there is no full time quality manager, the responsibilities could be assigned to another staff member.
5. The management requirements should contain a description of the policies regarding the scope of the activities of the SSDL and specify the various responsibilities for the operation of the laboratory and for administrative aspects with respect to the quality assurance programme.
6. The SSDL should seek feedback from its customers, analyze and use it to improve the management system. Procedures for the review of requests for services and handling of customer complaints should be available.
7. A procedure for procurement (tenders and contracts) should be also available.

3.4 Technical requirements

3.4.1 Personnel

1. Management shall ensure the competence of all who perform calibrations and fulfill the requirements for personnel certification (health, radiation protection etc). The staff shall have appropriate education, experience and relevant knowledge of the calibrations to be carried out.
2. A periodical training programme related to the tasks should be in place. A list of staff undergoing training and supervision shall be provided.
3. Records of current job descriptions (detailed responsibilities), and any special authorization to perform calibrations or issue the calibration certificates shall be maintained.

3.4.2 Accommodation and environmental conditions

1. Laboratory facilities, including energy sources, lighting and environmental conditions, shall be such as to facilitate correct performance of calibration.
2. The environmental parameters (temperature, atmospheric pressure, humidity, radiation background) which can influence the measured values shall be monitored and be according to the relevant standard test conditions published in ISO (ISO 4037, 8529, 6980) and IEC Standards.
3. Separation of calibration hall, control and service rooms is required. Access to a calibration hall shall be controlled. The laboratory premises should provide adequate radiation protection to prevent unintended personnel exposures and to provide safety and security of radiation sources. Emergency plans should exist for potential radiological incidents or accidents and fire.

3.4.3 Calibration and measurement methods and method validation (including safety and security aspects)

1. The laboratory shall use written methods and procedures for handling, transport, storage, of items to be calibrated.
2. For many types of dosimeters, monitors, survey meters and personal dosimeters the general calibration and testing procedures are published in international (ISO, IEC and IAEA) documents. The laboratory shall have a procedure stipulating the method or protocol followed for their calibration services.
3. When a non-standard method should be used, it shall be subject to an agreement with the client and shall have been documented and validated before use (special beam quality, irradiation

geometry, new data collection and evaluation software etc.).
4. Procedures for safe data storage and protection should be in place.
5. All approved relevant documents shall be made readily available to all staff.

3.4.4 Equipment

1. All items necessary for the calibration procedure shall comply with the relevant specifications of the protocol (radiation sources, standards, measuring and auxiliary instruments).
2. Irradiation facilities shall be operated by authorized personnel (X ray machine, gamma irradiators, accelerators).
3. Up-to-date written instructions, manuals on the use and maintenance of the equipment shall be readily available for the staff.
4. Equipment and software shall be uniquely identified, and verified periodically according to established procedures.
5. The laboratory shall maintain records of equipment.
6. Equipment that repetitively gives suspect results or is defective shall be taken out of service and clearly labeled.
7. The effect of the defective equipment on the previous calibrations shall be examined and corrective actions undertaken when necessary.
8. There should be a system to identify equipment, including the date when the recalibration is needed.
9. When intermediate checks are needed to maintain confidence in the calibration procedure, setup or used reference data (check source measurements, beam output measurements etc.), these checks shall be carried out and documented according to a defined procedure.

3.4.5 Traceability and uncertainty

1. The laboratory shall establish traceability of its own reference standards and measuring instruments to the SI by means of an unbroken chain of calibrations linking them to the relevant primary standard.
2. A complete uncertainty estimation should be made according to the IAEA-IAEA-TECDOC-1585 [5] or internationally agreed documents on this topic (BIPM, IEC, ISO).
3. Established recalibration periods for SSDL's standards shall be maintained. The recalibration period shall comply with national regulations and it shall not exceed 5 years.
4. It is recommended to use the reference standard dosimeter for establishing traceability and the working standards for calibration of customer equipment.

3.4.6 Handling of calibration items

1. The laboratory shall have procedures for identification, receipt, handling, storage and dispatch of calibration items.
2. In case of specific environmental conditions and security requirements they shall be maintained and monitored.
3. The laboratory shall contact the customer if any departure from the normal working conditions of the calibration item is identified, or the calibration required is not specified in sufficient detail.

3.4.7 Assuring quality of results

This can be ensured by:

1. Regular use of reference standard dosimeter for monitoring the reference dose rate values if a reference data base is used.
2. Participation in comparisons.
3. Replicate calibrations using the same or different methods.
4. Recalibration and monitoring of retained items.
5. Correlation of results for different characteristics of items (known energy response, N_{Dw}/N_{Ka} ratio of ionization chamber).

3.4.8 Reporting results

1. The results of a calibration shall be reported accurately, clearly, and objectively in accordance with any specific instruction in the calibration procedure.
2. The certificate may be a hard copy or electronic version provided the requirements of ISO/IEC 17025 standard are met.
3. The certificate shall state only the quantities related to the performed calibration.
4. When a statement of compliance with any specification is made, this shall identify which clauses of the specification (manufacturer or standard) are met or not met.
5. The calibration certificate (or label) shall not contain any recommendation on the calibration interval except where this has been requested by the client. This requirement may be superseded by national regulations.
6. Any amendment of certificate after issue shall be made in the form of further document stating clearly that it supplements one already issued document identified by its serial number.

7. When it is necessary to issue a complete new calibration certificate this shall be uniquely identified stating clearly that it supersedes one already issued certificate identified by its serial number.
8. Minimal information of the calibration certificate:
    - A title (e.g. 'Test Report' or 'Calibration Certificate')
    - Name and address of the laboratory;
    - Unique identification of the certificate (serial number) and each page identification (2nd page of 24);
    - Name and address of the client;
    - Identification of the method used and evidence that the measurements are traceable;
    - Description of, the condition of, and obvious identification of the item calibrated (type and serial number);
    - Date of receipt, where this is critical to the validity and application of the results, and date of calibration;
    - Standard test (environmental) conditions under which the calibration was performed;
    - Calibration result with expanded uncertainty, units of measurement and reference conditions for which the calibration factor (coefficient) is valid;
    - Name, function and signature of person(s) authorizing the calibration certificate.
    - Date of issue of the certificate.

4. AUDIT STRUCTURE

4.1 Request for audit

Comprehensive audits for SSDLs applying to become a regional designated centre and/or applying for funding through a TC project are mandatory otherwise they are voluntary. For mandatory audits the request for an audit will originate from the IAEA, otherwise it will originate from the SSDL to be audited.

The administration of the institution or their national regulator may also request for an audit. The head of the audited SSDL should endorse it, in order to assure optimum cooperation, and to maximize the benefit of the audit.

The institution requesting an audit must have the basic equipment infrastructure to deliver good quality calibration services as stipulated in Section 3. Should the IAEA realize that these criteria are not met, it could offer guidance on how to achieve this basic level.

In order for the audit team to be selected appropriately, all relevant information about the current status of the SSDL and the reasons for the audit need to be received by the IAEA prior to the visit for the audit. It is the responsibility of the requesting institution to clearly formulate the purpose of the audit and to transmit this to the IAEA.

4.2 Requirements of on-site audit team

The selected auditor(s) should normally have at least a degree qualification in a scientific/technological discipline related to ionising radiation dosimetry or equivalent. In some cases, extensive experience in the relevant field of expertise may be substituted for formal education.

The auditor must have experience in undertaking national or international assessments of calibration or testing laboratories, or be familiar with audit methodology, according to ISO/IEC 17025 [2]. Special competencies may be included (e.g. radiation protection). The auditor should have:

- At least 5 years experience in developing, providing or being responsible for a calibration or a measurement service in radiation dosimetry;
- 2 years experience of quality management, quality assurance or QMS auditing related to laboratory activities at the metrology institute level. In the absence of such experience the auditor should, during the assessment, work with a QMS expert who has participated in assessments for accreditation by a recognized accreditation body.

4.3 Preparation for the audit

The success of an audit depends heavily on the thorough preparation of all parties involved, including the SSDL, the audit team and the IAEA.

4.3.1 Role of the institution

1. Formulate the objectives of the audit in case of voluntary audit.
2. Prepare data and relevant documentation (quality manual including the scope of services to end users and technical procedures) to enable the auditors to complete their evaluation according to the format of the IAEA document and send to IAEA at least one month before the audit.
3. Provide material requested for any internal/external audit.
4. Identify and ensure participation of the individuals needed for the audit, although the audit team should be free to interview any staff member they deem appropriate.
5. Inform the entire SSDL staff and management of the audit and its time frame.
6. Make available any technical records (raw measurement data, calibration records and

certificates of all instruments used for calibration etc.) of any calibration/verification certificates that were performed for a customer.

4.3.2 Role of the audit team

Auditors are required to:

1. Be familiar with the audit procedures and prepare an audit plan describing the approach to the audit.
2. Review the preparatory and background information prepared by the SSDL and provided by the IAEA.
3. Request additional information if necessary via the IAEA.
4. Provide the IAEA with a comprehensive report about the visit.

4.3.3 Role of the IAEA

1. Request all the necessary data from the SSDL (type of organization, persons in charge, calibration service provided, equipment, workload etc.).
2. Review all prior interactions with the IAEA, (audits, calibration, comparisons, expert visits, reports etc). In case no audit or comparison results are available, the IAEA will arrange at least a TLD audit.
3. Inform the SSDL about the methodology of the audit (provide this document).
4. In collaboration with the requesting SSDL, prepare a clear outline of the objectives of the audit mission.
5. Select an appropriate audit team and provide its members with all necessary documentation and background information about the SSDL to be audited.
6. Ensure that appropriate instruments are available for witnessing a calibration in case this is part of an audit.
7. Brief the audit team, emphasizing the responsibility of the IAEA on the dissemination of the report.
8. Facilitate the introduction of the auditor(s) to the SSDL.
9. Assessment of the auditor's report and recommendation.
10. Follow-up on findings and corrective actions.

4.4 Procedures

4.4.1 Entrance briefing

An entrance briefing is required to introduce the auditor(s) to the various staff members of the SSDL and to discuss the methods, objectives and details of the audit. The auditor(s) should reassure the laboratory staff that all disclosed information will be treated as confidential and that confidentiality clause has been signed by the auditor(s) with the IAEA.

4.4.2 Assessment

Both the infrastructure and the overall functioning of the laboratory will be audited. The infrastructure includes staffing, equipment and facilities. All aspects of the laboratory programme starting with the request of a quote for calibration, to actually receiving the equipment, handling and storage, calibration, returning of the instrument to the customer with a certificate, invoicing and customer feedback will be examined. The SWOT (Strong–Weak–Opportunities–Threats) analysis could be used during the assessment.

Checklists have been designed (Appendix I) to help auditors organize the audit programme and to ensure coverage of all relevant topics. The detailed programme of an audit depends on the reasons for the audit, and a selection of topics may be made from the full audit checklists, as appropriate. The tools available include:

- A complete tour of the facility;
- Review of the QMS including documentation record keeping, internal and external audits;
- Staff interview;
- Practical measurements and other tests of the performance of local systems and procedures;
- Observation of practical implementation of working procedures.

4.4.3 Exit briefing

It is essential that auditor(s) present their preliminary feedback to the laboratory including all findings. At the completion of the audit, the institution should convene all members of the laboratory who were interviewed, for an interactive exit briefing. This will include time for questions, and should include a detailed and open discussion of all the findings of the experts.

The results of assessment including any identified non conformities should be presented in written format, using appendix II, along with preliminary recommendations during the exit briefing. The non conformities have to be agreed upon by both parties and signed. The institution should be encouraged to ask questions and make an initial response to the assessment. The steps intended by the institution to respond to the recommendations and improve the activities of the laboratory should also be discussed and recorded. When measurements have been performed as part of the audit, completed forms and calculations should be left with the institution.

4.5 Conclusion of the audit team

The audit team is expected to comment on how well the institution has met the criteria set out in the checklists. They will form and express an opinion regarding the appropriateness of the institute in fulfilling the minimum requirements set out in the document. They are also expected to comment on facilities, type, quality, and amount of equipment, level of experience, capability and training of personnel. If the department wishes to expand to new areas of expertise, appropriate separate recommendations will be made. Auditors may recommend whether a follow-up visit or internal audit is required.

With respect to the classification of the findings regarding infrastructure, facilities, equipment, and procedures, the audit team may identify two levels of findings:

1. *Major findings:* These will have a major impact on the quality of the results and/or the traceability chain. The solution to these findings may require involvement of the government or other bodies. The relevant recommendations need to be included in the audit report.
2. *Minor findings:* These will have a minor impact on the quality of the results and/or the traceability chain. They may either require minor changes, which are easy to implement at laboratory level, or involve major changes that require modifications to infrastructure and or equipment but are feasible for the laboratory. These will be included in the detailed recommendations of the audit team.

The action plan for clearing findings should be submitted to the IAEA after it has been approved by the auditor(s).

4.6 The audit report

The audit results are presented in the form of an audit report that consists of two parts, a summary report and a detailed report. The former will summarize the mission and its conclusion, while the latter will present the details of the audit, comments by the auditor(s), the audit conclusion and the recommendations, if any. The audit report must contain conclusions formulated in an unambiguous way, with clear and practical recommendations. To arrive at valid conclusions, the auditor(s) should address a series of key topics and measurements, which will constitute the objective part of the report. These items will then be discussed in order to produce a comprehensive document describing the audited laboratory. The report should be concise.

The contents of the detailed report should include [2, 6, 7, 8, 9]:

- Objectives of the audit;
- A brief description of the audit activities;
- Audit team and SSDL's participants;
- A description of the facility (infrastructure, workload, etc.);
- The findings and results of the visit including checklists, evaluation of mesurement procedures, software including its validation if appropriate and witnessed measurement procedures if any;
- Conclusions;
- Recommendations (to the institution, to the IAEA and to the government);
- Annexes including completed check lists.

It is important that the audit report mentions whether the site visit was welcomed or not. The degree of cooperation from the SSDL, laboratory staff and various members of the institution has a significant impact on the credibility of the final report. At all times, audit reports are confidential except for clearly designated recipients and the IAEA staff facilitating the audit.

It should be understood that while it is the responsibility of the IAEA experts to discuss shortfalls in the services of the audited laboratory, the audit does not necessarily commit the IAEA to rectify any deficiencies identified.

4.7 Dissemination of the report

The detailed audit report will only be sent to responsible personnel whose role in the institution is significant to the audit. These will be typically the head of the SSDL and the quality manager. The summary report shall be prepared by experts for dissemination to the relevant national authorities. Amongst these are the national TC liaison officer and the national permanent mission in Austria. This summary report will include a short description of the audit findings and its main conclusions. It should refer only to essential verifiable facts and exclude any value judgments.

Recommendations in the report will be directed to the institution, the national authorities, and to the IAEA. Recommendations to the IAEA should be confined to general statements, for example, the need for a follow-up visit. If the audit identifies the need for assistance (equipment, training etc.) this could be considered under a national or regional Technical Cooperation Project.

4.8 Follow up

The findings should be cleared within the time frame agreed upon with the IAEA and the auditor(s). The laboratory must send evidence to the auditor(s) via the IAEA with proof of clearing the corrective actions together with preventive actions, if any. The auditor(s)

shall review the evidence submitted by the laboratory and advise the IAEA on the final conclusion.

The IAEA will send auditor(s) every five years to reassess the capacity of the laboratory appointed to function as an RDC. Should the laboratory be subject to another audit according to ISO/IEC 17025 using an accreditation body that is a member of a regional cooperation body that is a member of ILAC (International Laboratory Accreditation Cooperation) and/or IAF (International Accreditation Forum), the IAEA may choose to use the conclusions of this audit. The laboratory appointed as an RDC should notify the IAEA immediately if the scope of calibration capabilities is altered or its infrastructure (staff, equipment, facilities) is subject to change. It is the right of the IAEA to reassess the laboratory or to review the RDC status.

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CONTRIBUTORS TO DRAFTING AND REVIEW

Drafters:

Aalbers, A.H.L.	Nederlands Meetinstituut, Netherlands
Csete, I.	Hungarian Trade Licensing Office, Hungary
De Souza Patrao, K.C.	Institute of Radiation Protection and Dosimetry, Brazil
Meghzifene, A.	International Atomic Energy Agency, Austria
Msimang, Z.L.M.	National Metrology Institute of South Africa, South Africa
Pernicka, F.	International Atomic Energy Agency, Austria

Reviewers:

Arib, M.	Nuclear Research Centre of Algiers, Algeria
Hourdakis, C.J.	Greek Atomic Energy Commission, Greece
Kapsch, R.-P.	Physikalisch-Technische Bundesanstalt, Germany
Saravi, M.	National Atomic Energy Commission, Argentina

Survey of calibration capabilities for diagnostic radiology detectors: preliminary analysis

Survey responses were received from 38 SSDLs, representing 37 different countries.

Question 1 'Do you currently have the facility to calibrate diagnostic radiology x ray dosimeters?'

19 Yes; however of these 4 were excluded for the following reasons:

1 site – one was from a commercial company with SSDL status. Their work was not typical of a country SSDL and in fact they recorded 4,881 detectors calibrated in 2007 using IEC beams and TRS457.

2 sites – were actually doing protection detector calibrations with ISO 4037 (one other centre also mentioned ISO 4037 but (correctly) did not check yes to question 1).

1 site – it was clear from the comments that they were not performing calibration or had the facility for diagnostic x ray dosimeters.

Further analysis of the **15 Yes** responses to Q1 showed that 3 did not perform calibrations in 2007 due to technical problems. In addition 2 other centres that checked **No** to Q1, but did perform calibration in 2007. Of the **15 Yes** responses 11 stated they followed TRS457, with 1 following a national protocol and 2 others using other protocols. All but one centre used some IEC beams (this other centre is being followed up – in case they are using ISO 4037), with 2 centres using additional non IEC mammography beam qualities. The breakdown of the IEC beam usage was:

13 RQR, 5 RQA, 4 RQR-M, 3RQA-M, 3 RQT.

For question 1 there were **19 No** responses, with **13** of these indicating they plan to have a facility within 3 years.

For question 4 'For a typical detector calibration how many calibration points are performed?' the mean of all who gave a non zero answer was 3.6, with a range of 1-7 points.

For question 5 'How many diagnostic detectors did you calibrate in 2007?' the mean of all who gave a non zero answer was 23.9, with a range of 5-60 detectors. The total number of detectors calibrated was 335.

Summary: From analysis of the returned survey forms it is possible to make the following points:

- Replies were received from 38 SSDLs representing 37 countries.
- Currently 15 SSDL sites have the facility to make diagnostic X rays for calibration, with a further 13 indicating they plan to have a facility in 3 years time.
- Of the 15 sites above, 11 follow TRS457 and 13 use IEC beam qualities.
- There is a large range in the activity of diagnostic radiology calibrations with a range of 5 to 60 detectors a year, with a total of 335 for 2007. The one commercial facility registered as an SSDL on the other hand calibrated 4,881 detectors in the same period.
- At some facilities there is some confusion about what is meant by diagnostic radiology calibration. This should not include activities of calibration for protection purposes using ISO 4037 beam qualities. Instead the publication TRS457 and appropriate IEC beam qualities should be used.

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Venezuela

INTERNATIONAL ATOMIC ENERGY AGENCY

Dosimetry and Medical Radiation Physics Section

Division of Human Health

THE IAEA/WHO NETWORK OF SSDLs

SURVEY ON CALIBRATION CAPABILITY FOR DIAGNOSTIC RADIOLOGY RADIATION DETECTORS

Could you please assist the IAEA by filling out the following survey form*. The gathered data will be used to help plan the implementation throughout the member states of diagnostic radiology calibration standards through the TRS457 document.

SSDL identification (optional): Country: _____ City: _____ Date: _____

1. Do you currently have the facility to calibrate diagnostic radiology x ray dosimeters? **YES** ☐ / **NO** ☐

   If NO, do you plan to have the above in the next 3 years? **YES** ☐ / **NO** ☐

2. Do you follow the TRS457 protocol (http://www-pub.iaea.org/MTCD/publications/PDF/TRS457_web.pdf) or another?

   ☐ **TRS457** ☐ **National protocol** ☐ **Other**

   (if not TRS457, please indicate: _____)

3. What beam qualities do you offer?

   - IEC beam qualities **YES** ☐ / **NO** ☐ Please specify:

   RQR _____ **(i.e. 2-10)** **RQA** _____ **RQR-M** _____ **RQA-M** _____ **RQT** _____ **Other** _____

   - Non IEC beam qualities **YES** ☐ / **NO** ☐ Please specify:

Target	Tube voltage (kV)	Filter (mm)	HVL (mm Al)
Example: Rh	25	0.025 Rh	0.351

4. For a typical detector calibration how many calibration points are performed? _____

5. How many diagnostic detectors did you calibrate in 2007? _____

6. Additional comments? _____

_____

_____

*Please send the form (e-mail, fax or letter) to:

Dosimetry and Medical Radiation Physics Section
Division of Human Health, International Atomic Energy Agency
Wagramer Strasse 5, PO Box 100, A-1400
Vienna, Austria Tel: 43 1 2600 21653
Fax: 43 1 26007 21662
E mail: dosimetry@iaea.org

Courses, Meetings and Consultancies in 2009

Courses and workshops

IAEA National Training Course in Quality Assurance in Diagnostic Radiology, Jakarta, Indonesia, 26 – 30 January 2009 (INS/6/009)

IAEA/RCA Regional Training Course in Quality Assurance in Nuclear Medicine for Medical Physicists, 18 – 22 February 2009, Dhaka, Bangladesh

Joint ICTP-IAEA Advanced School on Dosimetry in Diagnostic Radiology and its Clinical Implementation, 11-15 May 2009, Miramare, Trieste, Italy (see page 30)

Regional (AFRA) training course for Medical Physicists on Nuclear Medicine Image Processing, Analysis and Quantification, Bloemfontein, South Africa, 1-5 June 2009 (RAF/6/032)

IAEA National Training Course in Quality Assurance in Diagnostic Radiology, Sarajevo, Bosnia and Herzegovina, 8-12 June 2009 (BOH/6/009)

Regional (AFRA) training course: Hands-on course on performing an acceptance test of a dual-head gamma-camera, Gamma-camera Laboratory at IAEA's Seibersdorf Laboratories, 19-23 October 2009 (RAF/6/032)

Regional (AFRA) training course on the use of Information, Communication and Technology (ICT) material for Medical Physicists specializing in Nuclear Medicine, Accra, Ghana, 16-20 November 2009 (RAF/6/032)

Meetings and consultancies

Technical Meeting to prepare the International Dosimetry Symposium, Vienna, Austria, 16-18 February 2009

Consultants Meeting on Establishing a nuclear medicine physics handbook, IAEA, Vienna, Austria, 14-16 April 2009

Consultants Meeting on the Document 'Diagnostic Radiology Physics: A Handbook for Teachers and Students', IAEA, Vienna, Austria, 27-30 April 2009

First Research Coordination Meeting on CRP "Development of quantitative nuclear medicine imaging for patient specific dosimetry", IAEA, Vienna, Austria, 18-22 May 2009

Consultants Meeting on Drafting a Guide for Clinical Training in Nuclear Medicine (RAS/6/038), IAEA, Vienna, Austria, 25-29 May 2009

Research Coordination Meeting for the CRP on Development of quality audits for radiotherapy dosimetry for complex treatment techniques, IAEA, Vienna, Austria, 8-12 June 2009

The Abdus Salam
International Centre for Theoretical Physics

JOINT ICTP-IAEA ADVANCED SCHOOL
ON DOSIMETRY IN DIAGNOSTIC RADIOLOGY
And its Clinical Implementation

11 - 15 May 2009

Miramare, Trieste, Italy

The aim of this School is to contribute to the development of qualified and competent medical physicists, medical physics educators and metrologists by:

- Disseminating information about dosimetry for diagnostic radiology physics as described in the recently published TRS 457 'Dosimetry in Diagnostic Radiology: An international Code of Practice'. This document, in conjunction with ICRU 74, is the first standardised description of terms and processes in this field, forming a solid basis for dosimetry principles and practice that should be transferred to the medical radiological environment, particularly in developing countries,
- Facilitating the creation of a network for the exchange of information on radiology x-ray physics among scientists in developing and developed Member States.

For some time now there has been a growing awareness that radiation dose originating from medical diagnostic procedures in radiology, is contributing an increasing proportion to the total population dose and this is particularly evident for computed tomography and interventional fluoroscopy procedures. The dosimetry involved however can be surprisingly complex due to the diverse range of examination types, and the resultant development of new dosimetric measurement instruments, techniques and terminologies which present challenges to those working in the clinical environment, those supporting them in calibration facilities and those teaching in educational institutions. Recently the approach to radiology dosimetry has been standardised through publications from ICRU and IAEA. This advanced school will take a comprehensive approach to the principles of diagnostic x-ray dosimetry and the calibration of instruments, leading to recent developments in dose determination for advanced modalities such as digital imaging, CT and interventional radiology.

PARTICIPATION

The advanced school would seek to target medical physicists with responsibility in diagnostic radiology, metrologists and teachers involved in medical physics education programmes. Scientists and students from all countries which are members of the United Nations, UNESCO or IAEA may attend the School. As it will be conducted in English, participants should have an adequate working knowledge of this language. Although the main purpose of the Abdus Salam International Centre for Theoretical Physics is to help research workers from developing countries, through a programme of training activities within a framework of international cooperation, students and post-doctoral scientists from developed countries are also welcome to attend.
As a rule, travel and subsistence expenses of the participants should be borne by the home institution. Every effort should be made by candidates to secure support for their fare (or at least half-fare). However, limited funds are available for some participants from developing countries, to be selected by the organizers. There is no registration fee.

HOW TO APPLY FOR PARTICIPATION

The application form can be accessed at the activity website:

http://agenda.ictp.it/smr.php?2033

Once in the website, comprehensive instructions will guide you step-by-step, on how to fill out and submit the application form.

Telephone: +39-040-2240226 **Telefax: +39-040-22407226**

E-mail: smr2033@ictp.it

ICTP Home Page: http://www.ictp.it

December 2008

DIRECTORS

R. Padovani (EFOMP)

M. de Denaro (Trieste)

D. McLean (IAEA, Vienna)

LOCAL ORGANIZERS

L. Bertocchi (ICTP)

C. Tuniz (ICTP)

TOPICS

Dosimetry framework, quantities units and formalism

Selection of instrumentation

Calibration at an SSDL facility

Dosimetry in general radiography, fluoroscopy, interventional radiology, mammography, computed tomography and dental radiography

Use of phantoms and patient data in dosimetry

Dosimetry and DICOM

Organ dose estimation

Clinical calibration

APPLICATION DEADLINE

15 February 2009

Member Laboratories of the IAEA/WHO Network of SSDLs

Country	City	Contact person	Fax	E-mail
ALBANIA	Tirana	Mr. Kostantin Dollani	+35 5 42362596	kdollani@albmail.com
ALGERIA	Algiers	Mr. Mehenna Arib	+213 21 43 4280	mehenna.arib@yahoo.fr
ARGENTINA	Buenos Aires	Ms. Margarita Saraví	+54 11 6779 8228	saravi@cae.cnea.gov.ar
AUSTRALIA	Menai	Mr. Dimitri Alexiev	+612 97179325	jbd@ansto.gov.au
AUSTRIA	Seibersdorf	Mr. Hannes Stadtmann	+43/50550-3011	hannes.stadtmann@arcs.ac.at
BANGLADESH	Dhaka	Mr. Md. Shakilur Rahman	+880 2 8613051	shakilurssdl@yahoo.com
BELARUS	Minsk	Mr. Valery Milevsky	+375172880938	milevski@belgim.by
BELGIUM	Ghent	Mr. Hubert Thierens	+32 92 646699	hubert.thierens@rug.ac.be
BOLIVIA **	La Paz	Mr. Lucio R. Berdeja Amatller	+591 2 2433063	ibten@entelnet.bo
BRAZIL	Rio de Janeiro	Mr. Carlos J. da Silva	+55 21 3411 8163	carlos@ird.gov.br
BULGARIA	Sofia	Ms. Katya Sergieva	+35 9 29432 144	sergievakm@abv.bg
CANADA	Ottawa	Mr. Brian R. Gaulke	+16 1 39578698	brian_gaulke@hc-sc.gc.ca
CHILE	Santiago	Mr. Carlos Oyarzún Cortes	+56 2 3646 277	coyarzun@cchen.cl
CHINA *	Beijing	Mr. Gan Zeuguei	+86 10 444304	
CHINA	TaiYuan, Shanxi	Mr. Zhang Qingli	+86 351 7020407	zhangqing_li@hotmail.com
CHINA	Shanghai	Mr. Shi Hong	+86(21)50798270	hxdl@simt.com.cn
CHINA	Beijing	Mr. Jinsheng Cheng	+86 10 6201 2501	cjs3393@sina.com
CHINA	Hong Kong Sar	Mr. C.L. Chan	+85 2 29586654	cchan@ha.org.hk
CHINA	Beijing	Mr. Guo Wen	+86 1 69357178	rmcssdl@iris.ciae.ac.cn
COLOMBIA	Bogotá	Mr. Edgar Guillermo Florez Sañudo	+57 1 3153059	egflorez@ingeominas.gov.co
CROATIA	Zagreb	Mr. Branko Vekić	+385 1 4680098	bvekic@irb.hr
CUBA	Havana	Mr. Gonzalo Walwyn Salas	+53 7 682 9573	gonzalo@cphr.edu.cu
CYPRUS	Nicosia	Mr. Stelios Christofides	+357 22 603137	mpd@mphs.moh.gov.cy
CZECH REP. *	Prague	Ms. I. Horakova	+42 0 2738330	ihorak@suro.cz
CZECH REP.	Prague	Mr. Pavel Dryák	+42 0 266020466	pdryak@cmi.cz
CZECH REP.	Prague	Mr. D. Olejár	+42 0 267313119	dolejar@suro.cz
DENMARK	Herlev	Mr. Klaus Ennow	+45 4 4543450	sis@sis.dk
ECUADOR	Quito	Mr. Marcos M. Frías Sánchez	+59 3 22563336	comecen1@comecenat.gov.ec
EGYPT	El-Giza	Ms. Fawzia Ahmad Khalil	+20 2 3867451	nemadnis@netscape.net
ETHIOPIA	Addis Ababa	Mr. Melaku Minwuylet Anteneh	+251 911 63 72 19	nrpa@ethionet.et
FINLAND	Helsinki	Mr. Antti Kosunen	+35 8 975988450	antti.kosunen@stuk.fi
FRANCE	Fontenay-aux-Roses	Ms. Isabelle Clairand	+33 1 4746 97 77	isabelle.clairand@irsn.fr
GEORGIA	Tibilisi	Mr. Simon Sukhishvili	+99 5 32 613500	simoniko@list.ru
GERMANY	Neuherberg	Mr. Dieter F. Regulla	+49 8 93187192224	regulla@gsf.de
GERMANY	Freiburg	Mr. Christian Pychlau	+49 761 49055 70	pychlau@ptw.de
GERMANY	Schwarzenbruck	Mr. Igor Gomola	+49 9 12860710	igor.gomola@wellhofer.com
GHANA	Legon-Accra	Mr. Joseph Kwabena Amoako	+23 3 21 400807	rpbgaec@ghana.com; joekamoako@yahoo.com.uk
GREECE	Paraskevi-Attiki	Mr. Costas J. Hourdakis	+30 2 106506748	khour@eeae.gr
GUATEMALA	Guatemala C. A.	Mr. Angel Osorio	+50 2 2762007	arot23@yahoo.com
HUNGARY *	Budapest	Mr. István Csete	+36 1 458 5945	cseteis@mkeh.hu
HUNGARY	Budapest	Mr. Gabor Kontra	+36 1 2248620	kontra@oncol.hu
HUNGARY	Paks	Mr. Mihaly Orbán	+36 1 3551332	orbanmi@npp.hu
INDIA	Mumbay	Mr. Shri Suresh Rao	+91 2 225505151	suresh@barc.gov.in
INDONESIA	Jakarta Selatan	Mr. Susetyo Trijoko	+62 1 217657950	strijoko@batan.go.id

Country	City	Contact person	Fax	E-mail
IRAN, ISLAMIC REPUBLIC OF	Karaj	Mr. Mostafa Ghafoori	+98 261 4424058	mghafoori@nrcam.org
IRELAND	Dublin	Ms. Lorraine Currivan	+35 3 12697437	rpii@rpii.ie
ISRAEL	Yavne	Mr. Ben Shlomo	+97 2 89434696	abenshlomo@hotmail.com
KOREA, REP. OF	Seoul	Mr. Heon-Jin Oh	+82 2 3801352	radjin@kfda.go.kr
KUWAIT	Kuwait City	Ms. Ilham Elfares	+96 5 4862537	ssyyy12@yahoo.com
LATVIA	Salaspils	Mr. Antons Lapenas	+371 67901210	alap@latnet.lv
LIBYAN ARAB JAMAHIRIYA	Tripoli	Mr. Saleh A. Ben Giaber	+21 8 213614143	BenGiaber@yahoo.com
MADAGASCAR	Antananarivo	Mr. Raoelina Andriabololona	+26 1 202235583	instn@dts.mg
MALAYSIA	Kajang	Mr. Taiman Bin Kadni	+60 3 89250575	taiman@nuclearmalaysia.gov.my
MEXICO	Mexico City	Mr. Victor M. Tovar Munoz	+52 5 53297302	vmtm@nuclear.inin.mx
NORWAY	Osteras	Mr. Hans Bjerke	+47 6 7147407	Hans.Bjerke@nrpa.no
PAKISTAN	Islamabad	Mr. Waheed Arshed	+92 5 19290275	warshed@pinstech.org.pk
PERU	Lima	Mr. Tony Benavente A.	+51 1 488 5101	tbenavente@ipen.gob.pe
PHILIPPINES *	Diliman, Quezon	Ms. Estrella S. Caseria	+63 2 9201646	escaseria@pnri.dost.gov.ph
PHILIPPINES	Sta. Cruz, Manila	Ms. Nieva O. Lingatong	+63 2 711 6016	nolingatong@doh.gov.ph
POLAND	Warsaw	Mr. Wojciech Bulski	+48 2 26449182	w.bulski@rth.coi.waw.pl
PORTUGAL	Sacavém	Mr. J.A. Ferro de Carvalho	+35 1 219941995	aferroc@itn.pt
PORTUGAL	Lisbon	Mr. Paulo Ferreira	+35 1 217229877	radfisica@ipolisboa.min-saude.pt
ROMANIA	Bucharest	Mr. Constantin Milu	+40 2 13183635	cmilu@ispb.ro
RUSSIAN FED.	St. Petersburg	Mr. V.I. Fominykh	+7 812 3239617	info2101@vniim.ru
RUSSIAN FED.	St. Petersburg	Ms. Galina Lutina	+78 1 25966705	cherviakov.a@cards.lanck.net; crirr@peterlink.ru
SAUDI ARABIA	Riyadh	Mr. Abdalla N. Al-Haj	+96 614424777	abdal@kfshrc.edu.sa
SERBIA	Belgrade	Mr. Milojko Kovačević	+38 1112455943	milojko@vin.bg.ac.yu
SINGAPORE *	Singapore	Mr. Eng Wee Hua	+65 7 384468	
SINGAPORE	Singapore	Mr. Stephen Chong	+65 2 262353	sckmipil@pacific.net.sg
SINGAPORE	Singapore	Mr V.K. Sethi	+65 2 228675	trdwac@nccs.com.sg
SLOVAKIA	Bratislava	Ms. Viera Laginová	+42 1 252923711	vlaginov@ousa.sk
SLOVENIA	Ljubljana	Mr. Matjaz Stuhec		matjaz.stuhec@ijs.si
SOUTH AFRICA	Pretoria	Ms. Zakithi Msimang	+27 128412131/ 4458	zmsimang@@nmisa.org
SUDAN **	Khartoum	Mr. Ibrahim Idris Suliman	+249 (0)183774179	i.i.suliman@gmail.com
SWEDEN	Stockholm	Mr. Jan-Erik Grindborg	+46 8 7297108	ssi@ssi.se
SYRIAN ARAB REPUBLIC	Damascus	Mr. Mamdouh Bero	+96 3 116112289	atomic@aec.org.sy
TANZANIA, UNITED REP. OF	Arusha	Mr. Wilbroad E. Muhogora	+25 5 272509709	taec@habari.co.tz
THAILAND *	Bangkok	Mr. Kriengsak Bhadrakom	+66 2 5806013	
THAILAND	Nonthaburi	Mr. Siri Srimanoroth	+66 2 2239595	siri@dmsc.moph.go.th
THAILAND	Bangkok	Mr. Thongchai Soodprasert	+66 2 5620093	thongcha@oaep.go.th
THE FORMER YUGOSLAV REPUBLIC OF MACEDONIA	Skopje	Mr. Velko Velev	+00389 2 3215044 220	velkovelev@yahoo.com
TUNISIA	Tunis	Ms. Latifa Ben Omrane	+21 6 7171697	sadok.mtimet@rns.tn
TURKEY	Istanbul	Mr. Ata Türer	+90 212 4732634	dogan.yasar@taek.gov.tr
URUGUAY	Montevideo	Mr. Alejandro San Pedro	+59 8 29021619	calibraciones@dinaten.miem.gub.uy
VENEZUELA	Caracas	Ms. Lila Carrizales	+58 2 125041577	lcarriza@ivic.ve
VIETNAM	Hanoi	Mr. Vu Manh Khoi	+84 4 8363295	dung-khoi@hn.vnn.vn; vmkhoi@mail.vaec.g

** Provisional Network members; * SSDL Organization

COLLABORATING ORGANIZATIONS ASSOCIATED WITH THE IAEA/WHO NETWORK OF SSDLs

Bureau International des Poids et Mesures (BIPM)
International Commission on Radiation Units and Measurements (ICRU)
International Electrotechnical Commission (IEC)
Organisation Internationale de Métrologie Légale (OIML)
International Organization of Medical Physics (IOMP)

AFFILIATED MEMBERS OF THE IAEA/WHO NETWORK OF SSDLs

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Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)	Yallambie, AUSTRALIA
National Research Council of Canada (NRC-CNRC)	Ottawa, CANADA
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NMi Van Swinden Laboratorium	Delft, NETHERLANDS
National Radiation Laboratory (NRL)	Christchurch, NEW ZEALAND
Scientific Research Institute for Physical-Technical and Radiotechnical Measurements (VNIIFTRI)	Moscow, RUSSIAN FEDERATION
Laboratory of Ionizing Radiation, Slovak Institute of Metrology (SIM)	Bratislava, SLOVAKIA
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National Physical Laboratory (NPL)	Teddington, UNITED KINGDOM
National Institute of Standards and Technology (NIST)	Gaithersburg, UNITED STATES OF AMERICA

IAEA International Atomic Energy Agency

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1400 Vienna, Austria

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