SSDL Newsletter

IAEA/WHO NETWORK OF SECONDARY STANDARD DOSIMETRY LABORATORIES

No. 33
JULY 1995
ISSN 1011-2669

Prepared by the Joint IAEA/WHO Secretariat of the SSDL Network
Published by the INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, AUSTRIA

CONTENTS

EDITORIAL NOTE

Hans Svensson, Head of the IAEA Dosimetry Section left the Agency in August 1994 and returned to Sweden, Radiation Physics Department, University of Umea. Pedro Andreo was appointed Head of the Dosimetry Section, Division of Human Health at the IAEA in January 1995. He will initiate his activities in the Section in August 1995.

A REDUCED CV

Pedro Andreo was born in Spain in 1950. He graduated in Theoretical Physics in 1974, "licenciature" (M Sc) degree in 1975, and became Doctor in Physical Sciences in 1982 at the University of Zaragoza (Spain). After several years of scientific collaboration with the Dept of Medical Radiation Physics, Karolinska Institutet-University of Stockholm, he moved to Sweden as research fellow in 1987. He became Associated Professor in Radiation Physics at the University of Stockholm in 1989, being in charge of the education of Ph.D. and research students. Pedro Andreo was appointed Full Professor in Radiation Physics at the University of Lund (Sweden) in February 1993, and chief of Radiotherapy Physics of the University Hospital in Lund.

Since his Ph. D. on applications of the Monte Carlo method to dosimetry, scientific activities continued in different areas of Radiation Physics. He gave strong emphasis to the use of the Monte Carlo method to perform original calculations in Radiotherapy Physics, mainly data for dosimetry and treatment planning with electron and photon beams, becoming one of the pioneers of the field. He has been Dosimetry Consultant for the International Atomic Energy Agency (IAEA) since 1986, being co-author of the Spanish Dosimetry Protocol, the IAEA Code of Practice for the Dosimetry of Therapeutic Beams (IAEA TRS-277), and member of a report committee of the International Commission on Radiation Units and Measurements (ICRU). Recently his main research activities are addressed to improving the dosimetry of therapeutic proton beams and the use of "direct" Monte Carlo calculations for radiotherapy treatment planning. He is also involved in projects aiming at decreasing the uncertainty of the dose delivered to patients undergoing radiotherapy treatment.

He became interested in clinical radiation physics in 1973, and has hold training positions in Oxford, London, Sutton and Stockholm. He has worked as hospital physicist, mainly in the area of radiation therapy, between 1976-1987.

Since May 1994 he has been on a leave of absence from Lund, back to the Dept of Medical Radiation Physics, at the Karolinska Institute-University of Stockholm. In January 1995 he was appointed Head of the Dosimetry Section, Division of Human Health, at the IAEA. By virtue of his position, he is also the Secretary of the IAEA/WHO SSDL Network.

REPORT OF THE SIXTH MEETING OF THE SSDL SCIENTIFIC COMMITTEE (SSC)

Vienna, 6-9 March 1995

1. FOREWORD

The report of the fifth meeting (held in November 1992) of the SSDL Scientific Committee (SSC) was published in the SSDL Newsletter No. 31, December 1992.

The 6th meeting was held in Vienna at the Agency headquarters on 6-9 March 1995. At the beginning of the meeting K. Zsdánszky, Acting Head of the Dosimetry Section, reviewed the mission and functions of the Dosimetry Section. For the first two days the Agency staff presented reports on their various activities. For two more days the SSC met in closed session deliberating its recommendations. The participants in the meeting and the meeting agenda are listed as Appendix I and Appendix II, respectively. Since the position of the Head of the Dosimetry Section was vacant, the meeting was delayed from November 1994 to March 1995 until the future Section Head, Prof. Pedro Andreo, was available to attend.

According to the Terms of Reference the Committee evaluated the activities of the Dosimetry Section reported for 1993-1994 and discussed the dosimetry programme of the IAEA for 1995-96 and 1997-98. The scope of the evaluation was addressed to the fundamental questions of:

- the objective of the programme area;
- its impact (benefits to Member States);
- its continuing relevance as an Agency activity.

Specific advise or recommendations by the SSC are underlined in the text. Several general recommendations are reiterated at the end of the report.

2. INTRODUCTION

The Agency, in conjunction with WHO, has established a network of Secondary Standard Dosimetry Laboratories (SSDLs) that provides access to basic instrument calibrations for a large fraction of the world. The network provides access to a wide range of radiation dose standards in radiation therapy and radiation protection.

In radiation therapy, this proper calibration of dosimeters is the first link in the chain of events leading to an accurate delivery of radiation dose to the patients. The second link includes verification that the dosimeter was used properly to calibrate the radiation beam, and the third link is to verify that the prescribed radiation therapy dose is, in fact, delivered appropriately to patients. The Agency, WHO, some of the SSDLs, and several other review bodies have developed postal TLD services to monitor the second link, proper beam calibration. Over several years, the IAEA/WHO postal TLD service has successfully helped various radiotherapy centres to improve their dosimetry. However, present results show that as many as 25% of the results are still outside the Agency/WHO acceptance criteria (±5%). As presently construed, the Agency programme is unable to resolve the bulk of these discrepancies, so the Agency has begun to look for new methods to resolve these

discrepancies. The methods include encouraging the establishment of programmes at SSDLs, or facilities affiliated with SSDLs, which may be in a better position to focus on the resolution of discrepancies.

In recent years, the Dosimetry Section has made significant strides to establish secondary standards and develop a postal dosimeter for high-dose irradiations. The Dosimetry Section has also just begun efforts in brachytherapy and this report will suggest additional efforts in radiation safety in collaboration with NENS. The Agency plans to transfer successful techniques learned in the external beam radiotherapy programme, to these other pertinent programmes. Diagnostic radiology and nuclear medicine, although of lower priority, could also benefit from access to standards and quality assurance procedures.

3. REPORT

The SSC was presented with reports of the many facets of the Dosimetry Section programme in support of its stated mission. This report will summarize those activities of the Section for which the SSC has comments or recommendations.

3.1 PROJECT 3.01: SECONDARY STANDARD DOSIMETRY LABORATORY (SSDL) NETWORK

There are presently 72 SSDLs in the IAEA/WHO Network representing 56 countries, of which 32 are developing countries and another 13 are less than fully developed countries. These laboratories provide metrology standards and dosimetry services in external beam radiotherapy, radiation safety and a few of them in high-dose irradiations. The principle ongoing activities of the SSDL Network are in radiation therapy- and protection-level dosimetry. The Agency's internal quality assurance of this programme is particularly commendable and assures reproducibility of the Agency secondary standards to a high level of precision. This conclusion was verified by a consultants meeting in December 1993 on "External Quality Audit of the Absorbed Dose Intercomparison Methods used by the IAEA".

3.1.1 CALIBRATION OF SECONDARY STANDARDS AND HOSPITAL REFERENCE DOSIMETERS, AND COMPARISONS WITH SSDLs

The Laboratory Unit of the Agency's Dosimetry Section at Seibersdorf provides calibration of therapy-level dosimeters to SSDLs as needed, 10 to 15 per year. In addition, the Agency had developed two measurement assurance programmes to monitor the quality of the standards disseminated by the SSDLs. TLDs are mailed to each SSDL on an annual basis, irradiated by the SSDL and returned to the Agency for evaluation. This programme is successful and provides gross measurement assurance (acceptable agreement is ±3.5%). A second system, termed CARE, which involves shipping dosimeter systems to the SSDLs for high-level measurement assurance (at the 0.5% level), has been problematic and terminated. Presently the Agency is testing a replacement high-precision system. This involves shipment of a field ionization chamber, calibrated at the SSDL, to the Agency where the calibration factor is compared to that assigned by the Agency. For those SSDLs that cannot provide component calibration (chamber and electrometer calibrated independently), a constant current source has

been developed by the Agency to determine the contribution to the system calibration factor from the charge measuring device. A chamber calibration factor can then be inferred.

The annual postal comparison has been shown to be successful in assuring the coherence of the measurement quality of the SSDL Network in the range of therapeutic doses. This programme should be extended to assure the traceability of secondary standards also at radiation protection irradiation level. The SSDLs with activity in high-dose dosimetry participate in the International Dose Assurance Service (IDAS) of the Agency.

The annual TLD comparisons between the Agency and the SSDLs show that some SSDLs are outside the acceptable criterion (±3.5%). For these cases, repeating the TLD comparison is essential and usually results in reducing the discrepancy. If this is not the case, the Agency must take special efforts, including visits to the SSDLs by an expert, to resolve the discrepancy.

The SSC noted that not all pertinent SSDLs participate in the annual TLD programme. In order for the Agency to be able to assure the validity of the standards disseminated by the SSDLs, it is essential that all SSDLs, with therapy-level calibration capabilities, participate in the annual comparisons. The SSC also noted that approximately 15 to 20% of the SSDLs have not submitted an activities report to the Agency in the past 3 years. In addition, discrepancies in the reports continue. The Agency is advised to update the questionnaire to improve the quality of the data, and query the SSDLs to determine those that are really interested in continued participation (i.e. produce a list of actively participating SSDLs).

3.1.2 DEVELOP EQUIPMENT AND PROCEDURES USED IN THE AGENCY LABORATORY FOR SSDL OPERATIONS

A small, portable, and easy to use constant current source has been developed by the Laboratory Unit of the Dosimetry Section and presented as a modification to the implementation of the CARE programme. Before implementation of this system, the constant current source should be subjected to tests at national metrology laboratories as well as SSDLs, to study the effects of quantities that influence the current (temperature, humidity, age, etc.).

3.1.3 CALIBRATE INSTRUMENTS FOR DOSIMETRY IN DIAGNOSTIC RADIOLOGY

The instantaneous dose rates and levels of required accuracy are lower for diagnostic radiology than for radiation therapy. However, interest in maximum diagnostic information from the minimum patient dose has heightened the public interest in the quality of dose measurements in diagnostic radiology. This modality could benefit greatly from access to the international measurement system. The SSC recommends that the Agency postpone formal action on this project until findings of other groups (e.g. in UK, USA) are available. This is an area where technical co-operation may have solid possibilities.

3.1.4 CARRY OUT REVISIONS OF TECHNICAL REPORT SERIES NO. 277: ABSORBED DOSE IN PHOTON AND ELECTRON BEAMS - AN INTERNATIONAL CODE OF PRACTICE.

A Consultant's Meeting (December 1992) evaluated several shortcomings and technical errors in the Code of Practice. The results have been published as a working material document: "Review of Data and Methods Recommended in the International Code of Practice..."[1]. The recommendations of the consultant group were that TRS No. 277 should not be revised at that time but an erratum sheet be included with the report, and an addendum to the report be developed for the use of plane parallel ionization chambers. The erratum sheet has been completed (see SSDL Newsletter No. 31, Dec. 1992) and the plane parallel chamber document is under development.

There is an increased interest in measurement standards laboratories and in the radiologic community for the direct calibration of ion chambers in terms of absorbed dose to water. The SSC recommends that a consultant group be convened in a timely fashion to study the development of a new Code of Practice to replace TRS No. 277 based on an absorbed dose to water standard. Before the application of the new method by the SSDLs sufficient experience and confidence on the new practice should be attained.

3.1.5 CRP ON THE PRACTICAL PROBLEMS ENCOUNTERED IN CALIBRATION PROCEDURES IN SSDLs

A consultant group was convened in October 1994. The SSC trusts that the consultant group report will propose future action to be taken by this CRP.

The IAEA Technical Report Series No. 374: "Calibration of Dosimeters used in Radiotherapy" (1994) has been published. As TRS No. 374 represents the basis for internal quality assurance to establish consistent transfer of standards by the SSDLs, the SSC recommends that this document be provided free of charge to all SSDLs that demonstrate active participation by timely submission of annual reports to the Agency and regular participation in the annual TLD comparison (see also 3.1.1).

3.2 PROJECT 3.02: DOSE INTERCOMPARISON AND ASSURANCE

The Agency has developed postal dosimeters for both radiation therapy (TLD) and for high-dose irradiations (alanine). TLD were evaluated for 310 therapy beams since December 1992, of which 78 were megavoltage x-ray beams. More than 30% of the TLD results are outside the Agency's ±5% criterion and nearly 15% have discrepancies exceeding ±10%. Only 50% of the repeat TLD to these institutions yield results within the 5% criterion.

It is imperative that the Agency pursue all avenues to develop efficient mechanisms to resolve these discrepancies at participating institutions. Lessons learned at radiotherapy dose levels should be applied to the alanine programme developed for high-dose irradiations.

---

[1] Report available upon request from the IAEA Dosimetry Section.

3.2.1 PERFORM DOSIMETRY SERVICE USING TLD FOR COBALT-60 UNITS AND LINEAR ACCELERATORS

The Agency and WHO, over the past four years, has expanded its postal TLD service from strictly cobalt 60 to megavoltage photon and electron beams. Intercomparisons of megavoltage photon beams have been performed with 12 facilities expected to have reliable dose values. From these intercomparisons, an energy dependence curve has been developed and TLD sent to participating institutions world-wide. Similar energy dependence determinations are ongoing by the Agency for the electron beams. The second round of the pilot electron beam study will be accomplished this spring and it is expected that the programme will be ready for general use by the end of 1995.

At this time, the Agency, WHO, and several SSDLs provide a regular postal TLD service to radiotherapy centres, and the Agency has outlined several approaches to provide comprehensive quality audit to all radiotherapy centres world-wide. It should be stressed that the recommended approaches to the comprehensive quality audit should provide sufficient *flexibility*: the national or regional infrastructure for such efforts should be taken into consideration, and duplicate efforts should be avoided. The quality audit organization must have the equipment and expertise not only to provide a reliable postal TLD service or other methods of audit, but also to resolve apparent discrepancies, possibly through follow-up visits by a local expert. For any such efforts to be successful, it is imperative that the quality audit organization and its operation is supported by the local medical physics community. Co-operation with the local radiation oncology societies and the support of local medical societies and health ministries are also highly desirable and are indispensable in many cases.

An SSDL or another institution, having the above support and demonstrated competence and resources, can in some cases be very effective in providing the comprehensive quality audit. In other cases, a suitable co-operation between the SSDL, a radiotherapy hospital or a research institute, and the authorities might provide the audit and the follow-up in the most efficient way. Intractable problems may require a visit by international experts with extensive expertise in quality audit activities. The Agency should review the situation in various countries, for the developing countries in particular, and to encourage the development of quality audit organizations which fulfil the basic criteria envisaged above.

3.2.2 PERFORM DOSE COMPARISONS IN BRACHYTHERAPY

The Agency staff discussed the need for a dosimetry and quality assurance programme in brachytherapy treatments, particularly in the use of conventional and high-dose rate brachytherapy sources. The plan for the programme for IAEA activity in brachytherapy will be developed during a consultants meeting scheduled in May 1995. The plan will include advice as to participating in the programme by the SSDLs.

3.2.3 PERFORM INTERNATIONAL DOSE ASSURANCE SERVICE (IDAS) FOR HIGH-DOSE IRRADIATION FACILITIES

Alanine samples evaluated by ESR have been shown to be effective postal dosimeters for applications in the dose range from 100 Gy to 100 kGy. The programme for an International

Dose Assurance Service (IDAS) was begun by the Agency in 1985 under contract with a research institute to provide the laboratory procedure. The programme was moved to the Agency in 1992 to assure traceability, to maintain local control, and to provide the opportunity to expand to other programmes. Traceability to BIPM, PTB, BEV, and NPL has been established through ionization chambers, Fricke, and K-dichromatic dosimeters.

To date, approximately 30 institutions have participated in the mailed alanine programme, of which approximately 1/3 are commercial facilities and the remaining are national laboratories or small research facilities. Approximately 60% of all dose checks show agreement within 5%. The present situation makes it desirable to expand the service to offer direct access for individual participants.

Members of an Advisory Group Meeting recommended that the Agency establish a standing advisory committee for high-dose irradiation activities. The group recommends that the membership of the SSC be expanded to include one person experienced in high-dose dosimetry. This will meet the spirit, if not the letter, of the advisory group recommendation.

3.2.4 CONDUCT A CRP ON DEVELOPMENT OF QUALITY CONTROL TECHNIQUES FOR PARTICLE BEAM (ELECTRONS) RADIATION PROCESSING

The objective of this CRP is to develop a reliable dose reference and dosimetry technique to achieve quality control especially for electron beam high-dose radiation processing. A dose intercomparison using Alanine/ESR is ongoing among 9 laboratories. The final report of this CRP will identify the suggested direction of Alanine/ESR for electron dosimeters.

3.3 PROJECT 3.03: TRANSFER OF DOSIMETRY TECHNIQUES

3.3.1 CONDUCT CRP ON QUALITY ASSURANCE PROGRAMMES FOR RADIATION THERAPY DOSIMETRY IN DEVELOPING COUNTRIES

The Agency expected a report of the consultants meeting in December 1994. This report will identify the directions to be taken by the Agency to improve transfer responsibility for postal TLD systems to the radiotherapy community where resolution of discrepancies should be more efficient. The Agency's role will be to maintain traceability of these programmes to international standards.

3.3.2 PREPARE TECHNICAL REPORT ON DETERMINATION OF DOSE TO AN ARBITRARY POINT IN A PATIENT

A group of consultants is presently working on this report. The SSC reminds the consultants writing the report that it should have three sections:

- Summarize the Agency Code of Practice for determination of dose at a reference point (TRS No. 277), in an early chapter.

- Present a unified methodology for calculating dose to an arbitrary point in a homogeneous phantom starting from the dose at the reference point.

- Provide practical procedures for measuring the dosimetry parameters needed in the unified methodology.

3.3.3 CONDUCT CRP ON CODE OF PRACTICE FOR RADIATION MEASUREMENTS WITH PLANE PARALLEL IONIZATION CHAMBERS

A draft of the Code of Practice is in preparation and should be completed in 1995 and available for testing by the CRP before it is published (see also section 3.1.4).

3.3.4 CONDUCT CRP ON EVALUATION OF HIGH-DOSE REFERENCE DOSIMETRY TECHNIQUES

This CRP is devoted to improvement of dosimeters in use at present and to develop reference dosimetry techniques especially for electron beams below 4 MeV and photon beams. This CRP is in the process of initiation.

3.4 TECHNICAL CO-OPERATION PROGRAMMES

The SSC thanks the Agency staff for making the list of technical co-operation projects available to us. The committee discussed the mechanisms for initiating a technical co-operation programme, and the frustration felt over the possibility that some of these programmes may be initiated contrary to recommendations of various programmes of the Agency or WHO.

The SSC suggests that support through technical co-operation may be needed in the following areas:

- Travel for experts and other procedures to follow up on suspected discrepancies at radiotherapy centres identified by the postal TLD service;

- Purchase of TLD equipment and portable dosimetry equipment for SSDLs to set up a TLD service to monitor radiotherapy centres in the region;

- Replace and update old or obsolete equipment at the SSDLs;

- To support training courses at SSDLs that wish to upgrade its facilities or extend them to quality audit of radiotherapy centres in the region. Physicists from local hospitals as well as SSDL personnel should be included in the training sessions.

3.5 TRAINING PROGRAMME

Transfer of the responsibility for some training courses to SSDLs continues.

a) Training courses to be organized by the Agency

An interregional training course on calibration procedures and quality assurance in SSDLs scheduled in 1996 has been postponed to 1999.

A regional training course on quality assurance in radiation therapy dosimetry (Middle East and Europe) scheduled for 1995 has been cancelled because of lack of funding. Another (Asia) is scheduled for 1996.

A regional training programme on modern techniques and dosimetry in brachytherapy of malignant neoplasm (Latin America) is scheduled for 1995, and one on treatment planning techniques and dosimetry in radiotherapy (Africa) has been postponed to 1997.

b) Seminar

A regional seminar on radiation dose in radiotherapy from prescription to delivery (Asia) is scheduled in the Asia and Pacific Region in 1995.

c) Symposia

A symposium on quality assurance in radiotherapy dosimetry (organized in co-operation with the International Society for Radiation Oncology) is scheduled at the Agency in May 1995. The proceedings to be published as an IAEA Technical Document is scheduled for printing in 1996. The SSC discussed the possibility that proceedings from this type of symposium be published in a less formal fashion, perhaps a "working material" document. The proceedings would then be available in a more timely fashion.

3.6 STAFFING

The SSC wishes to thank the Director General for the two new staff positions approved in 1995. These two posts give stability to the activities that were previously pursued by temporary staff.

The SSC notes that due to increasing need by developing countries in this field, particularly in quality assurance, in the past 7 years the workload of the Dosimetry Section increased remarkably. The service to Member States provided by the Laboratory Unit of the Dosimetry Section (at Seibersdorf) has doubled; however, funding has remained level. This report recommends that the Section expand its programme into brachytherapy using the facilities of the SSDL Network, which will involve development of standards, as well as quality assurance procedures, including postal dosimeters. In addition, this report recommends that the Section apply lessons learned in radiation therapy quality assurance to assure the traceability of secondary standards also at radiation protection irradiation level. This will involve additional efforts by the Dosimetry Section. The Agency will not be able to implement these recommendations with its present staff and funding resources. The SSC therefore recommends that several staff positions, at least temporary positions, be identified and that the

operating budget for the Dosimetry Section be critically evaluated and expanded to meet the needs of these activities.

4.0 RECOMMENDATIONS

The various recommendations of the SSC are interspersed in the above text. However several recommendations are reiterated here.

4.1 The Agency should take whatever efforts are necessary to develop efficient and effective methods to resolve discrepancies identified by the various quality assurance programmes. This applies both to discrepancies found at the SSDLs and at other individual participants.

4.2 The Agency should make inquiries of the SSDLs to determine which are clearly interested in remaining an active member of the SSDL Network. This interest is expressed in the timeliness of activity reports to the Agency and in willingness to resolve discrepancies or deficiencies in their programmes.

4.3 The Alanine/ESR programme for high-dose irradiations should be made available for direct access by individual participants.

4.4 The membership of this committee (the SSC) should be increased by one person, to include a person experienced in the dosimetry of high-dose irradiations.

4.5 A consultant group should be convened to study the development of a new Code of Practice based on an absorbed dose to water standard to replace TRS No. 277.

5. CONCLUSIONS

The SSC wishes to commend the staff of the Dosimetry Section for developing and maintaining the present programme and for their comprehensive review of the programme for our committee. The review reaffirmed that the activities of the Section cover the principle aims of the Section. The laboratory procedures provide a particularly robust link of the local dose standards to the international measurement system.

The IAEA/WHO Network of SSDLs has been successful in making radiation dose standards available in virtually all regions of the world. The Agency is poised to make significant contributions to quality assurance at individual radiotherapy centres. Energy and resources should be channelled into developing links with the SSDLs and/or advanced radiotherapy centres from which monitoring of local radiotherapy centres can most efficiently be accomplished. The Agency already has several plans for the implementation of such relationships. The SSC is confident that these programmes will have a significant impact on the quality of the radiation dose delivered to individual patients. The Alanine/ESR programme appears adequately developed to begin profitable interaction with individual irradiation facilities. Lessons learned from the radiotherapy TLD programme should be utilized in the Alanine/ESR programme.

The SSC commends the Agency for its continued support of the Dosimetry Section programmes. It also commends the Dosimetry Section staff for their competent and professional execution of their jobs within the framework of the various programmes.

ABBREVIATIONS

BEV	Bundesamt für Eich- und Vermessungwesen (Austria)
BIPM	Bureau International des Poids et Mesures
CARE	Coherence and Accuracy of Reference Instrumentation
CRP	Co-ordinated Research Programme
ESR	Electron Spin Resonance
IAEA	International Atomic Energy Agency
ICRU	International Commission on Radiation Units and Measurements
IDAS	International Dose Assurance Service
NENS	Division of Nuclear Safety
NPL	National Physical Laboratory (UK)
PCI	Physics, Chemistry and Instrumentation (Laboratory Seibersdorf)
PTB	Physikalisch-Technische Bundesanstalt (Germany)
RIHU	Division of Human Health
SSC	SSDL Scientific Committee
SSDL	Secondary Standard Dosimetry Laboratory
TLD	Thermoluminescent Dosimeter
TRS	Technical Report Series
WHO	World Health Organization

Appendix I

PARTICIPANTS

Committee members:
Prof. A. Allisy, ICRU, Chairman of SSC
Dr. K. Chongkitivitya, Thailand
Dr. W.F. Hanson, USA
Dr. H. Järvinen, Finland
Dr. A. Leitner, Austria
Dr. J.W. Müller, BIPM

WHO:
Dr. G. Hanson, WHO Secretary of the SSDL Network

IAEA consultant:
Prof. P. Andreo, Sweden (Spain)

IAEA staff members:
Mr. P. Bera, Dosimetry Section, Laboratory Unit Seibersdorf
Mr. L. Czap, Dosimetry Section, Laboratory Unit Seibersdorf
Mr. R. Girzikowsky, Dosimetry Section, Laboratory Unit Seibersdorf
Mr. R. Griffith, NENS, Radiation Safety Section
Mr.G. Matscheko, Dosimetry Section
Mr. K. Mehta, Dosimetry Section
Mr. P. Nette, Dosimetry Section, Head of Laboratory Unit Seibersdorf
Mr. P. Ortiz Lopez, NENS, Acting Head, Radiation Safety Section
Ms. A. Shanta, Dosimetry Section
Mr. Vl. Valkovic, Head, PCI Laboratory, Seibersdorf
Mr. K. Zsdánszky, Acting Head, Dosimetry Section

Appendix II

AGENDA

- Opening address by **A. Cuarón,** Director, Division of Human Health
- Introductory remarks by **G.P. Hanson** (WHO), Co-secretary of the IAEA/WHO SSDL Network, and **K. Zsdánszky**, Acting Head, Dosimetry Section
- Adoption of the Agenda
- Nomination of Rapporteur

1.	Overview of the programme by the Dosimetry Section	K. Zsdánszky
2.	Statistical data on the SSDL Network	K. Zsdánszky G. Matscheko
3.	Laboratory activities of the Section	P. Nette
	3.1 Maintaining of IAEA reference standards for therapy- and protection-level dosimetry	L. Czap
	3.2 Comparisons with SSDLs	
	a) TLD method	P. Bera
	b) Ionization chamber method	L. Czap
	3.3 TL postal dosimetry service for radiotherapy centres	P. Bera
	3.4 *Participation in the Quality Audit Network for* radiotherapy dosimetry	P. Nette
4.	IAEA activities on high-dose measurements	K. Mehta R. Girzikowsky
5.	Brachytherapy dosimetry	A. Shanta
6.	Co-ordinated Research Programmes (CRPs)	K. Mehta P. Nette
7.	Technical Co-operation activities	G. Matscheko K. Mehta P. Nette
8.	Publications	K. Zsdánszky G. Matscheko
9.	Radiation protection activities in NENS	R. Griffith
10.	Dosimetry programme of the IAEA in 1995-96 and 1997-98	K. Zsdánszky
11.	*Any other business*	

UNCERTAINTY OF THE CALIBRATION FACTOR

The IAEA published recently "Calibration of Dosimeters Used in Radiotherapy, Technical Reports Series No. 374", a revised version of TRS No. 185. One of the important reasons for the revision was that new method had been recommended by the Bureau International des Poids et Mesures (BIPM) for the expression of uncertainty in measurement. In order to help SSDLs to apply it as soon as possible, one part of Chapter 10. of TRS No. 374 has been included in this SSDL Newsletter. The author of this part, J.W. Müller of the BIPM, kindly agreed to have it published in this issue.

1. INTRODUCTION

The method used in this document for estimating the uncertainty pertaining to the result of a measurement is that outlined in BIPM Recommendation INC-1 [1], approved by the Comité International des Poids et Mesures (CIPM) in 1981. The task of developing a detailed guide based on this unified approach was transferred in 1986 to the International Organization for Standardization (ISO). This resulted in the ISO document: "Guide to the Expression of Uncertainty in Measurement" in 1993 [2], which should be consulted for further details. Those interested in an elementary presentation of the new approach can find a summary in IAEA Technical Reports Series No. 277 [3], Appendix A.

2. GENERAL CONSIDERATIONS ON ERRORS AND UNCERTAINTIES

Contrary to previous practice, when the terms "error" and "uncertainty" were used interchangeably, the modern approach, initiated by the CIPM, distinguishes between these two concepts. This can probably best be seen from a schematic representation (Fig. 1). It may be useful to distinguish between an ideal and a practical situation. Note that the concepts true value and error no longer appear in the practical evaluation.

According to present definitions, an *error* is the difference between a measured value and the "true" value. Thus an error has both a numerical value and a sign. In contrast, the *uncertainty* associated with a measurement is a parameter that characterizes the dispersion of the values "that could reasonably be attributed to the measurand" [2]. This parameter is normally an estimated standard deviation. An uncertainty, therefore, has no known sign and is usually assumed to be symmetrical. It is a measure of our lack of exact knowledge, after all recognized "systematic" effects have been eliminated by applying appropriate corrections.

If errors were known exactly, the true value could be determined and there would be no problem left. In reality, errors are estimated in the best possible way and corrections made for them. Therefore, after application of all known corrections, errors need no further consideration (their expectation value being zero) and the only quantities of interest are uncertainties.

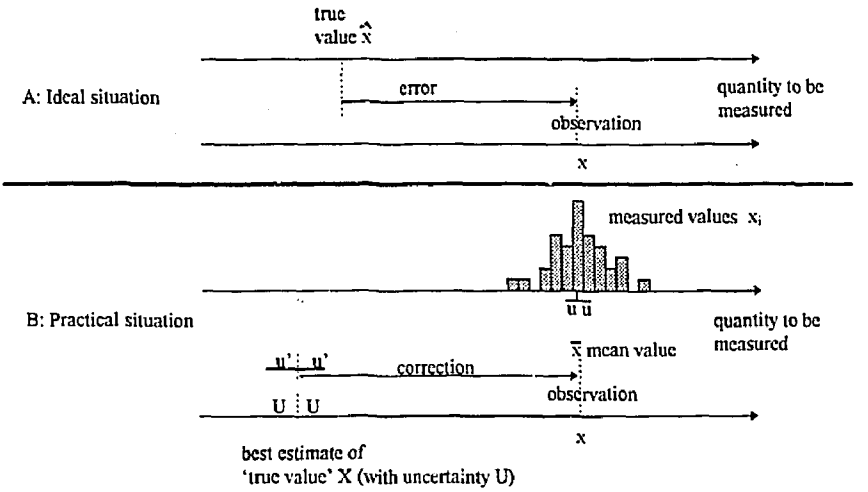

FIG. 1. Schematic representation of some basic concepts related to measurement uncertainties.

The estimation of an uncertainty may be made by some known statistical method (Type A) or otherwise (Type B). This distinction is mainly of pedagogical relevance and it can be dropped once the numerical values for the uncertainties have been chosen.

In the traditional categorization it was usual to distinguish between "random" and "systematic" contributions. However, one should realize that this classification depends on how an uncertainty is used in a given physical context. It may occasionally still be quite useful, but one must not think that such a classification requires different propagation laws (see Section 6.).

3. TYPE A STANDARD UNCERTAINTIES

In a series of n measurements, with observed values x_i, *the best estimate of the* quantity x is usually given by the *arithmetic mean* value

$$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i \,. \qquad (1)$$

The scatter of the measured values around their mean $\bar{x}$ can be characterized, for an individual result x_i, by the *standard deviation*

$$s(x_i) = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2} \quad , \tag{2}$$

and the quantity $s^2(x_i)$ is called the empirical variance of a single measurement, based on a sample of size n.

We are often interested in the standard deviation of the mean value, written as $s(\bar{x})$, for which the general relation

$$s(\bar{x}) = \frac{1}{\sqrt{n}} s(x_i) \tag{3}$$

applies. An alternative way to estimate $s(\bar{x})$ would be based on the outcome of several groups of measurements. If they are all of the same size, the formulae given above can still be used, provided that x_i is now taken as the mean of group i and $\bar{x}$ is the overall mean (or mean of the means) of the n groups. For groups of different size, "statistical weights" would have to be used. This second approach may often be preferable, but it usually requires a larger number of measurements. A discussion of how much the two results of $s(\bar{x})$ may differ from each other is beyond this elementary presentation.

The *standard uncertainty of Type A*, denoted here by u_A, will be identified with the standard deviation of the mean value, i.e.

$$u_A = s(\bar{x}) \, . \tag{4}$$

Obviously, an empirical determination of an uncertainty cannot be expected to give its "true" value; it is by necessity only an estimate. This is so for both Type A and Type B uncertainties. It will be noted from Eq. (3) that a Type A uncertainty on the measurement of a quantity can, in principle, always be reduced by increasing the number n of individual readings. If several measurement techniques are available, the preference will go to the one which gives the least scatter of the results, i.e., which has the smallest standard deviation $s(x_i)$, but in practice the possibilities for reduction are often limited. One example is the measurement of a background radiation which varies over the time intervals of interest. Another is when a very low dose rate produces ionization currents which are of the same order as the leakage currents, which may also be variable. In order to arrive at an acceptable uncertainty of the result, it is then necessary to take many more readings than would normally be needed in a typical x-ray or γ-ray beam.

In the past, uncertainties due to random effects have often been evaluated in the form of confidence limits, commonly at the 95 % confidence level. This approach is not used in the CIPM scheme presented here because there is no statistical basis for combining confidence limits. The theory of the propagation of uncertainties requires combination in terms of variances.

The Type A standard uncertainty is obtained at the SSDL by the usual statistical

analysis of repeated measurements. It is not expected that a Type A standard uncertainty will be determined individually for each instrument calibrated at the SSDL, but rather that representative values will be obtained from a number of typical calibrations. It is normally found that the reproducibility of each model of dosimeter is essentially the same from one instrument to the next. Thus, if the Type A standard uncertainty of an air-kerma-rate measurement is determined for one kind of dosimeter, the same value can generally be used for other instruments of that same model, measured under the same conditions.

4. TYPE B STANDARD UNCERTAINTIES

There are many sources of measurement uncertainty that cannot be estimated by repeated measurements. They are called Type B uncertainties. These include not only unknown, although suspected, influences on the measurement process, but also little-known effects of influence quantities (pressure, temperature, etc.), application of correction factors or physical data taken from literature, etc.

In the CIPM method of characterizing uncertainties, Type B uncertainties must be estimated so that they correspond to standard deviations; they are called *Type B standard uncertainties*. Some experimenters claim that they can estimate directly this type of uncertainty, while others prefer to use, as an intermediate step, some kind of limit. It is often helpful to assume that these uncertainties have a probability distribution which corresponds to some easily recognizable shape. Perhaps the most common assumption is that Type B uncertainties have a distribution that is approximately Gaussian (normal). On this assumption, the Type B standard uncertainty can be derived by first estimating some limits $\pm$ L and then dividing that limit by a suitable number.

If, for example, the experimenter is "fairly sure" of the limit L, it can be considered to correspond approximately to a 95 % confidence limit, whereas if the experimenter is "almost certain", it may be taken to correspond approximately to a 99 % confidence limit. Thus, the Type B standard uncertainty u_B can be obtained from the equation

$$u_B = \frac{L}{k}, \tag{5}$$

where k = 2 if the experimenter is fairly certain, and k = 3 if he is quite certain of his estimated limits $\pm$ L. These relations correspond to the properties of a Gaussian distribution and it is usually not worthwhile to apply divisors other than 2 or 3 because of the approximate nature of the estimation.

It is sometimes assumed (see Fig. 2) - mainly for the sake of simplicity - that Type B uncertainties can be described by a rectangular probability density, i.e. that they have equal probability anywhere within the given maximum limits -M and +M. It can be shown that with this assumption the Type B standard uncertainty u_B is given by

$$u_B = \frac{M}{\sqrt{3}}. \tag{6a}$$

Alternatively, if the assumed distribution is triangular (with the same limits), we are led to the relation

$$u_B = \frac{M}{\sqrt{6}} . \qquad (6b)$$

There are thus no rigid rules for estimating Type B standard uncertainties. The experimenter should use his best knowledge and experience and, whatever method is applied, provide estimates that can be used as if they were standard deviations. It is hardly ever meaningful to estimate Type B uncertainties to more than one significant figure, and certainly never to more than two.

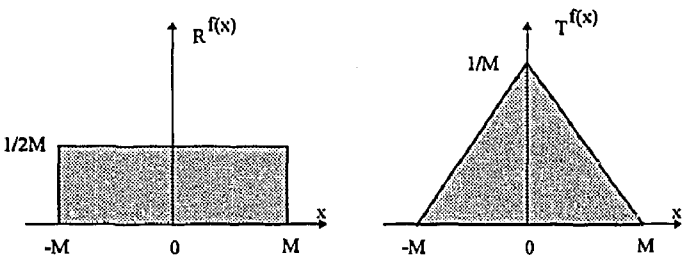

FIG. 2. The two simple probability density functions, $_R f(x)$ and $_T f(x)$, with rectangular or triangular shape, may be useful models for unknown distributions.

5. COMBINED UNCERTAINTIES AND EXPANDED UNCERTAINTIES

Because Type A and Type B uncertainties are both estimated standard deviations, they are combined using the statistical rules for combining variances (which are squares of standard deviations). If u_A and u_B are the Type A and the Type B standard uncertainties of a quantity, the combined standard uncertainty of that quantity is

$$u_C = (u_A^2 + u_B^2)^{1/2} . \qquad (7)$$

The combined standard uncertainty thus still has the character of a standard deviation. If, in addition, it is believed to have a Gaussian probability density, then the standard deviation corresponds to a confidence limit of about 66 %. Therefore, it is often felt desirable to multiply the combined standard uncertainty by a suitable factor, called the *coverage factor* k, to yield an *expanded uncertainty*. Suitable values of the coverage factor would again be k = 2 or 3, corresponding to confidence limits of about 95 % or 99 %. The approximate nature of uncertainty estimates, in particular for Type B, makes it doubtful that more than one significant figure is ever justified in choosing the coverage factor. In any case, the numerical value taken for the coverage factor should be clearly indicated. The expanded uncertainty is also known under the name "overall uncertainty".

6. PROPAGATION OF UNCERTAINTIES

The expression "propagation of errors" was part of the statistical terminology before it became customary to distinguish between errors and uncertainties, and it is still used occasionally. In order to be consistent with the present terminology, we prefer to talk about the propagation of uncertainties in what follows.

Consider first a practical example. The calibration factor determined by a given SSDL is not only based on various measurements performed at the laboratory, but also on correction factors and physical constants, as well as on a beam calibration traceable to a PSDL, the IAEA and, ultimately, to the BIPM. All these numerical values contain uncertainties and they combine to give a final uncertainty in the calibration factor. This situation can be represented in more general terms by considering a variable y which is a function f of a number of variables a, b, c, ... This can be written in the form

$$y = f(a, b, c, ...) \; . \tag{8}$$

It is assumed that all known corrections have already been applied to the variables and that the remaining uncertainties are small. For a given set of known deviations Δa, Δb, Δc, ..., one would expect that the quantity y becomes $y + \Delta y$, with

$$\Delta y \approx \frac{\partial f}{\partial a} \Delta a + \frac{\partial f}{\partial b} \Delta b + \frac{\partial f}{\partial c} \Delta c + \ldots \; , \tag{9}$$

where terms of higher order in the series expansion are neglected.

Unfortunately, this relation is of little practical use since none of the deviations is actually known; if they were, we would have already taken them into account by a corresponding correction. In addition, we do not know the signs of the various possible deviations and, for reasons of symmetry, their values can even be expected to be zero on average. Hence, Eq. (9) as it stands is only of formal interest. If we want to arrive at something that is related to more useful quantities, we must try to form quantities like "averaged squares". By squaring the previous relation we find

$$(\Delta y)^2 \approx (\frac{\partial f}{\partial a} \Delta a)^2 + (\frac{\partial f}{\partial b} \Delta b)^2 + \ldots + 2 \frac{\partial f}{\partial a} \frac{\partial f}{\partial b} \Delta a \, \Delta b + \ldots \; , \tag{10}$$

again restricting ourselves to the lowest non-vanishing order. An important step towards such quantities is made by the following identifications with expectation values:

$$E\{(\Delta a)^2\} = \sigma^2(a), \quad E\{(\Delta b)^2\} = \sigma^2(b), \quad \text{etc.}, \tag{11}$$

where $\sigma^2(a)$ stands for variance of a, etc. Similarly, the expected product of two deviations, for instance for a and b, i.e.

$$E\{\Delta a\ \Delta b\} = \sigma(a,b)\ , \tag{12}$$

is identified with the covariance of the quantities a and b, and similarly for other variables.

This is a useful procedure because it allows us to interpret our vaguely defined "deviations" by means of well-known statistical quantities. It is true that, in practice, we do not have access to the expectation values, as the samples we deal with are always of finite size. However, even for a limited number m of measurements of a quantity a, with the results $a_1, a_2, \ldots, a_m$, we can obtain a valid approximation to the variance $\sigma^2(a)$ by forming

$$s^2(a) = \frac{1}{m-1}\left\{\sum_i a_i^2 - \frac{1}{m}\left(\sum_i a_i\right)^2\right\}\ , \tag{12a}$$

and similarly for the covariance of a and b

$$s(a,b) = \frac{1}{m-1}\left\{\sum_i a_i\, b_i - \frac{1}{m}\left(\sum_i a_i\right)\left(\sum_i b_i\right)\right\}\ , \tag{12b}$$

with all sums extending from 1 to m.

With these conventions adopted, Eq. (10) leads us to the required *propagation law of uncertainties*, namely

$$u(y) = \left[\left(\frac{\partial f}{\partial a}\right)^2 u^2(a) + \left(\frac{\partial f}{\partial b}\right)^2 u^2(b) + \left(\frac{\partial f}{\partial c}\right)^2 u^2(c) + \ldots + 2\,\frac{\partial f}{\partial a}\,\frac{\partial f}{\partial b}\,u(a,b) + \ldots\right]^{1/2}\ , \tag{13}$$

where, for simplicity, we have made the identifications $\sigma(a) \equiv s(a) \equiv u(a)$, etc.

This equation provides the general relation looked for as it tells us how, for a known functional dependence y = f(a, b, c, ...), the individual uncertainties u(a), u(b), ..., of the quantities a, b, ..., are combined to evaluate the uncertainty u(y) of the required quantity y. The only other quantities appearing in (13), apart from the partial derivatives, are the covariances, such as u(a,b).

It is sometimes more practical to use correlation coefficients instead of covariances. For the variables a and b, this quantity is defined by

$$\rho(a,b) = \frac{\sigma(a,b)}{\sigma(a)\ \sigma(b)} \equiv \frac{u(a,b)}{u(a)\ u(b)}\ . \tag{14}$$

Correlation coefficients have the advantage of being dimensionless and to be necessarily between -1 and +1.

If two variables are strongly correlated (positively or negatively, i.e. in the same or in opposite directions), $|\rho|$ is close to unity, and in such a situation its effect on the propagation law cannot be neglected. In many practical cases, however, the influence quantities a, b, ..., are essentially independent of each other. Then $\rho \cong 0$ and the propagation law takes the simple form

$$u(y) \cong \{(\frac{\partial f}{\partial a})^2 u^2(a) + (\frac{\partial f}{\partial b})^2 u^2(b) + (\frac{\partial f}{\partial c})^2 u^2(c) + \ldots\}^{1/2}, \qquad (15)$$

which is valid for *independent* variables a, b, c, ...

Two *special cases* should be mentioned in particular since they are of great practical importance and cover large part of the usual situations.

If the functional dependence is linear, i.e. for *sums* (or differences), we have

$$y = Aa + Bb + Cc + \ldots, \qquad (16)$$

where the coefficients A, B, C, ... are constants. Since the partial derivatives are simply

$$\frac{\partial f}{\partial a} = A, \quad \frac{\partial f}{\partial b} = B, \quad \ldots \quad \text{etc.},$$

the uncertainty on y is

$$u(y) = \{A^2 u^2(a) + B^2 u^2(b) + C^2 u^2(c) + \ldots\}^{1/2}. \qquad (17)$$

Thus, if independent variables are added (or subtracted), the variances also add. In other words, the uncertainty of the sum is obtained by adding in quadrature the "weighted" uncertainties of the independent variables, where the "weights" are the squares of the coefficients A, B, ... ("adding in quadrature" means taking the square root of the sum of the squares).

The other special case concerns a *product* (or ratio) of independent variables. The functional dependence then is

$$y \propto a^{\alpha} b^{\beta} c^{\gamma} \ldots, \qquad (18)$$

where the exponents α, β, γ, ... are constants. In this case, we obtain from Eq. 15 the following expression for the relative uncertainty on y

$$r(y) = \{\alpha^2 r^2(a) + \beta^2 r^2(b) + \gamma^2 r^2(c) + \ldots\}^{1/2}, \qquad (19)$$

where $r(a) \equiv u(a)/|a|$ is the relative uncertainty of a, etc.

Thus, for a product (or ratio) of independent variables, the relative weighted variances add, where the weights are the squares of the exponents α, β, ...

A very common case is that of a ratio, $y = a/b$, where the quantities a and b contain measurements and correction factors. From Equation (19) the relative variance on y is equal to the quadratic sum of the relative uncertainties on a and b.

The foregoing discussion applies to Type A, Type B, and combined standard uncertainties, all of which are estimated so as to correspond to standard deviations. The rules for propagation of uncertainty also apply to expanded uncertainties, provided that the same coverage factor k has been used. The uncertainty on published data is generally in terms of an expanded uncertainty, or some equivalent terminology. This must then be converted into a standard deviation, before using it to calculate an uncertainty. If no coverage factor is stated, it may be assumed to have the value $k = 2$.

Both Type A and Type B standard uncertainties should be tabulated separately. This will make a possible later change easier to perform.

REFERENCES

[1] BUREAU INTERNATIONAL DES POIDS ET MESURES, Recommendation INC-1, Procès-Verbaux Comité International des Poids et Mesures, 49 (1981).

[2] INTERNATIONAL ORGANIZATION FOR STANDARDIZATION, Guide to the expression of uncertainty in measurement, ISBN 92-67-10188-9, ISO, Geneva (1993).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Absorbed dose determination in photon and electron beams, Technical Reports Series No. 277, IAEA, Vienna (1987).

HIGH-DOSE INTERCOMPARISON IN ^{60}Co FIELDS

Report of the IAEA to the BIPM, CCEMRI Section I [1], (April 1995)

Nine cobalt high dose calibration laboratories have collaborated with the Dosimetry Section, IAEA, in a "double-blind" intercomparison of absorbed dose in water in the 10-15 kGy dose range. BIPM undertook the analysis of the results as well as assisting in the development of the protocol. The participating laboratories were:

Nordion International (Canada)	NIM (China)
Risø Denmark)	DAMRI (France)
ENEA (Italy)	JAERI (Japan)
NIST (U.S.A>)	NPL (U.K.)

A consultant meeting was convened at the Agency on 5-7 April 1995 to discuss the results, which it is intended should be published in the open literature. A brief outline of the intercomparison is given below.

IAEA alanine/ESR transfer dosimeters were distributed to participants for irradiation under controlled conditions to nominal dose values of 15 and 45 kGy. After irradiation, the dosimeters were returned to the IAEA for evaluation, without notification of the dose given. Irradiation details and dose values from each participant were sent directly to BIPM, as were the results of the dose measurements made by the Agency.

Figure 1 shows the ratio of stated dose for each participant. For the convenience of presentation, the ratios have been normalised to the average ratio for all participants. The uncertainty bars shown are the overall uncertainty (1σ) in absorbed dose delivery stated by the individual participant concerned. The standard deviation of the population shown are 2.0% at 15 kGy and 2.3% at 45 kGy.

Although not seen on the figure, the mean of the dose values measured by IAEA was within 1% of the mean of the dose values stated by the participants for both dose levels.

One of the recommendations of the consultant meeting was that the BIPM should consider organizing and coordinating a similar intercomparison involving all national laboratories active in the high-dose (kGy) field.

[1] Section I (x and gamma rays, electrons) of the Comité Consultatif pour les étalons de Mesures des Rayonnements Ionisants

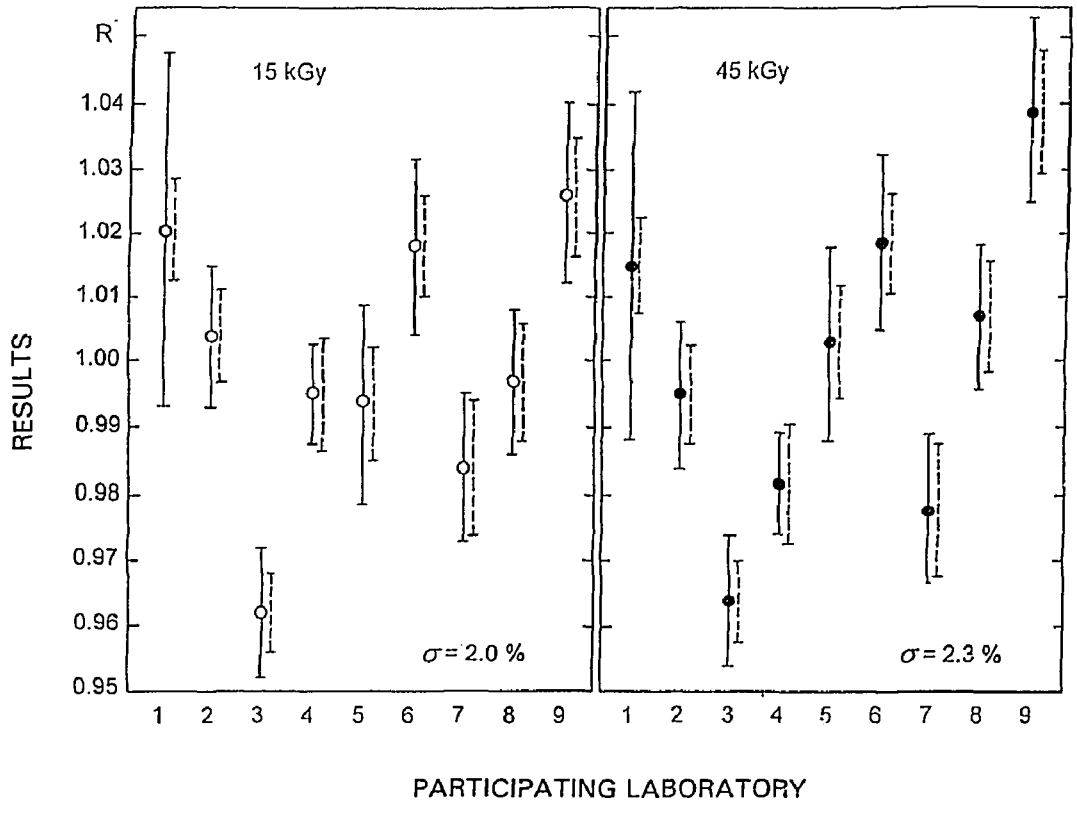

Fig. 1. Results of the intercomparison (Uncertainty bars: |-----| participants; |-----| IAEA)

NEWS

Regional Training course on Modern Techniques and Dosimetry in Brachytherapy of Malignant Neoplasia. Place: Mexico City Time: November 6 - 17 1995.

Organizers: IAEA in co-operation with the government of Mexico.
Course Director: Victor Tovar ININ, Mexico City.

Participation is open to all clinically active medical physicists and radiation oncologists in the Latin American region. Maximum number of participants is 25.

The following subjects are covered:

- Brachytherapy sources, physical properties, clinical use and source strength calibration
- Interstitial implant
- Basic brachytherapy dosimetry
- Computer aided HDR and LDR brachytherapy treatment planning
- Clinical radiobiology dose prescription and specification
- Clinical and technical aspects of LDR and HDR brachytherapy
- Quality Assurance in brachytherapy
- Planning and implementation of a brachytherapy programme
- A number of lectures as well as practical sessions on specific treatments.

Professor Jeffrey Williamson, St. Luis, USA, is acknowledged for his skilled and dedicated preparation of the course programme and for the excellent course faculty suggested by him.

Regional Seminar on: Radiation Dose in Radiation Therapy from Prescription to Delivery Place; Bangkok. Time; 28 November - 1 December 1995.

Organizers: IAEA in co-operation with the government of Thailand.
Scientific secretary of the seminar: Professor Pedro Adreo and Dr. Georg Matscheko

Invited speakers: Prof. K. Kawachi, Japan
Dr. K. Sakata, Japan
Prof. T. Landberg, Sweden
Dr. E. Brioth, France

Seminar Topics:

- Accuracy requirements in radiation therapy - biological backgrounds.
- Equipment requirements for external beam- and brachy- therapy.
- Absolute dose determination,dosimetry chain, dosimetry protocols.
- treatment planning, patient fixation and simulation in external beam therapy.
- Dosimetry and treatment planning in brachytherapy.
- quality assurance programmes in radiotherapy.
- Future modalities in radio therapy.

A Regional Training course on Quality Assurance in Radiation Therapy Dosimetry. Place; Manila, Philippines. Time; October 1996.

Organizers: IAEA in co-operation with the government of the Philippines.

Participation: The course is open for 20 participants and 10 observers from IAEA Member States in the Asia and Pacific region. The participants should be currently clinical active medical physicists.

The following subjects will be covered:

- Radiotherapy in treatment of tumours
- Tumour localization and treatment simulation
- Radiotherapy equipment
- Physical dosimetry
- Clinical dosimetry
- Treatment and follow-up
- Equipment quality control theory and practice.

The **4th International Symposium on ESR Dosimetry and Applications**, which was organised in co-operation with the IAEA, was held in Munich, 15-19 May 1995. It was very successful with approximately 200 technical papers being presented. The Dosimetry Section presented three papers at the symposium. The Agency's transfer dosimeter for the high-dose programme is alanine-ESR, and it is presently being evaluated at the Agency's laboratory for possible use for radiotherapy applications complementing the TLD system.

The **Third International Workshop on Dosimetry for Radiation Processing**, organized by the American Society for Testing and Materials (ASTM), Canada, 1-6 October 1995. About 130 participants from 21 countries; about 25% from countries other than from Canada and USA This workshop takes place about every three years and is the only of its kind for industrial dosimetry. The Workshop includes four types of sessions: plenary (overview) sessions, round-table discussion groups, hands-on exercises, and poster and demonstration session. One of the staff of the Dosimetry Section is the Programme Vice-Chairman and one invited paper is presented from the Dosimetry Section.

A working meting on **"National programmes of Quality Assurance in Radiotherapy"** was held at IAEA headquarters in Vienna during May 8 - 9 1995. The meeting was jointly organized by IAEA and ISRO (International Society for Radiation Oncology). About 120 scientists from 30 nations participated in the meeting. The main items discussed were: "Experience on current status. Quality control procedures for equipment - principles and methodology"; "Implementation of QA programmes at the institutional, national, regional and interregional levels"; "Experiences on current status from national networks". A panel discussion on "Role of networks. What is a network? Role? Advantages?" was held. Finally a session to make consensus statements on "multi-institutional Quality Assurance programmes" with representatives from IAEA, ISRO, IOMP, EFOMP, ESTRO, EORTC AND EC concluded the meeting. IAEA staff from the Radiation Protection Section, Dosimetry Section and Applied Radiation Biology and Radiotherapy Section participated in the meeting.

New activities coming up at the IAEA Dosimetry Section.
A consultants' meeting on "Quality Assurance Programme in Brachytherapy" was held in Vienna during 22-24, May 1995 to formulate a working programme for quality assurance in brachytherapy dosimetry within the Dosimetry Section at IAEA. On the basis of the discussions during the meeting, the Agency is now initiating a programme to develop procedures for calibration of brachytherapy sources.

159 1 19552 1E

MS M. AVEDIKIAN
NESI
A-2416

IAEA

SSDL NEWSLETTER
DOSIMETRY SECTION – DIVISION OF HUMAN HEALTH
INTERNATIONAL ATOMIC ENERGY AGENCY
WAGRAMERSTRASSE 5, P.O. BOX 100
A-1400 VIENNA, AUSTRIA

Printed by the IAEA in Austria
January 1996