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***Review of Radiation Oncology Physics:  
A Handbook for Teachers and Students***

***Editor***

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## **PREAMBLE**

Radiation therapy, also referred to as radiotherapy, radiation oncology or therapeutic radiology, is one of the three principal modalities used in treatment of malignant disease (cancer), the other two being surgery and chemotherapy. In contrast to other medical specialties that rely mainly on the clinical knowledge and experience of medical specialists, radiotherapy, with its use of ionising radiation in treatment of cancer, relies heavily on modern technology and collaborative efforts of several professionals whose coordinated team approach greatly influences the outcome of the treatment.

The radiotherapy team consists of radiation oncologists, medical physicists, dosimetrists, and radiation therapy technologists: all professionals characterized by widely differing educational backgrounds and one common link – the need to understand the basic elements of radiation physics and the interaction of ionising radiation with human tissue in particular. This specialized area of physics is referred to as *radiation oncology physics* and proficiency in this branch of physics is an absolute necessity for anybody who aspires to achieve excellence in any of the four professions constituting the radiotherapy team.

This book is dedicated to students and teachers involved in programmes that train professionals for work in radiation oncology. It provides a compilation of facts on the physics as applied to radiation oncology and as such will be useful to graduate students and residents in medical physics programmes, to residents in radiation oncology, as well as to students in dosimetry and radiotherapy technology programmes. The level of understanding of the material covered will, of course, be different for the various student groups; however, the basic language and knowledge for all student groups will be the same. The text will also be of use to candidates preparing for professional certification examinations be it in radiation oncology, medical physics, dosimetry, or radiotherapy technology.

The intent of the text is to serve as a factual supplement to the various textbooks on medical physics and to provide basic radiation oncology physics knowledge in the form of a syllabus covering all modern aspects of radiation oncology physics. While the text is mainly aimed at radiation oncology professionals, certain parts of it may also be of interest in other branches of medicine that use ionising radiation not for treatment of disease but for diagnosis of disease (diagnostic radiology and nuclear medicine). The content may also be useful for physicists who are involved in studies of radiation hazards and radiation protection (health physics).

I would like to thank all the authors for their contributions as well as colleagues and my wife Mariana for advice and encouragement throughout this project.

*Ervin B. Podgorsak*



## **FOREWORD**

In the late nineties, following a re-focusing of the work within the Dosimetry and Medical Radiation Physics Section (DMRP), the IAEA initiated a systematic and comprehensive plan to support the development of teaching programmes in medical radiation physics for many of its Member States. Multiple projects were initiated at various levels which, together with the well known short-term training courses and specialization fellowships funded by IAEA Technical Cooperation Projects, aimed at supporting countries to develop their own university-based M.Sc. programmes in medical radiation physics.

One of the early programmatic activities by DMRP in this period was the development of a "Syllabus in Radiotherapy Physics", with the goal of harmonizing the various levels of training that the IAEA provided, mainly through short-term courses. This was done during 1997-1998 by a group of physicists from Europe and North America with long experience in the teaching of medical physics (B. Nilsson, Sweden; B. Planskoy, UK; J.C. Rosenwald, France; and N. Suntharalingam, USA) under the supervision of the then DMRP Section Head, P. Andreo. The result of this work was released as an internal report (IAEA DMRP-9802), and its success encouraged the next step aimed at supporting more directly the material used in the various M.Sc. programmes.

In 1999 a consultants' meeting (R. Alfonso, Cuba; E. Podgorsak, Canada; G. Rajan, India; W. Strydom, South Africa; and N. Suntharalingam, USA) was conducted under P. Andreo's supervision to analyze the task to be implemented. The possibility of writing a "Primer in Radiotherapy Physics", based on the Syllabus above, which would provide physicists in developing countries with a modern and affordable text book was considered first. Arguments against this option were the wide availability of several excellent basic books in Radiotherapy Physics (even if it was difficult to recommend one in particular as being comprehensive), and the risk that the Primer would simply become another book, not necessarily better than the existing ones. Ultimately, a second option seemed more reasonable, which was to develop a "Teachers Guide", where the various topics in the Syllabus would be expanded to form a detailed "bullet list" containing the basic guidelines of the material to be included in each topic so that lectures to students could be prepared accordingly. This should include a comprehensive bibliography in order to harmonize the content of the lectures in different sites. During 1999-2000 the consultants named above prepared an initial draft of some chapters. After the departure of P. Andreo from the IAEA, J. Izewska took on responsibility for the project and searched for an editor to build the Guide and fulfill its initial goal.

During the period 2001-2002, E. Podgorsak (Canada) was appointed editor of the project and under the supervision of K. Shortt, the new DMRP Section Head, and in conjunction with J. Izewska, he implemented a change in strategy that led to the successful completion of the entire project. With enormous enthusiasm and professionalism, he redesigned the contents so that the book became a comprehensive "Handbook for Teachers and Students", with coverage deeper than a simple Guide. As well, he expanded considerably the initial list of topics by engaging an enhanced list of international contributors.

## *Foreword*

The “Handbook for Teachers and Students in Radiation Oncology Physics” aims at providing the basis for the education of medical physicists initiating their university studies in the field. It is not designed to replace the large number of textbooks available, which will still be necessary to deepen the level of knowledge in specific topics reviewed by the Handbook since it now includes the most recent advances in radiation therapy techniques available today. It is expected that the Handbook will successfully fill a gap in the teaching material for the specialty of Medical Radiation Physics, providing in a single manageable volume the largest possible coverage available today. Its wide dissemination by the IAEA will contribute undoubtedly to the harmonization of education in the field and be of value to new comers as well as those preparing for their certification as medical physicists.

At this stage, the IAEA is publishing the Handbook as “working material” seeking comments, corrections and feedback.

IAEA scientific officers of the project were: P. Andreo, J. Izewska and K. Shortt.

# **TABLE OF CONTENTS**

## Chapter 1. **BASIC RADIATION PHYSICS**

<b>1.1.</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1.1.	Fundamental physical constants	1
1.1.2.	Important derived physical constants and relationships	2
1.1.3.	Physical quantities and units	3
1.1.4.	Classification of forces in nature	4
1.1.5.	Classification of fundamental particles	4
1.1.6.	Classification of radiation	5
1.1.7.	Classification of ionizing photon radiation	6
1.1.8.	Relativistic mass, energy, and momentum relationships	6
1.1.9.	Radiation quantities and units	6
<b>1.2.</b>	<b>ATOMIC AND NUCLEAR STRUCTURE</b>	<b>7</b>
1.2.1.	Basic definitions for atomic structure	7
1.2.2.	Rutherford's model of the atom	9
1.2.3.	Bohr's model of hydrogen atom	10
1.2.4.	Multi-electron atoms	12
1.2.5.	Nuclear structure	13
1.2.6.	Nuclear reactions	14
1.2.7.	Radioactivity	14
1.2.8.	Activation of isotopes	17
1.2.9.	Modes of radioactive decay	18
<b>1.3.</b>	<b>ELECTRON INTERACTIONS</b>	<b>19</b>
1.3.1.	Electron-orbital electron interactions	20
1.3.2.	Electron-nucleus interactions	20
1.3.3.	Stopping power	21
1.3.4.	Mass scattering power	22
<b>1.4.</b>	<b>PHOTON INTERACTIONS</b>	<b>23</b>
1.4.1.	Types of indirectly ionizing photon radiations	23
1.4.2.	Photon beam attenuation	23
1.4.3.	Types of photon interactions	24
1.4.4.	Photoelectric effect	25
1.4.5.	Coherent (Rayleigh) scattering	25
1.4.6.	Compton effect (incoherent scattering)	26
1.4.7.	Pair production	29
1.4.8.	Photonuclear reactions	29
1.4.9.	Contributions to attenuation coefficients	30
1.4.10.	Relative predominance of individual effects	31
1.4.11.	Effects following photon interactions	32
1.4.12.	Summary of photon interactions	33
1.4.13.	Example	34



## *Table of Contents*

1.4.14.	Production of vacancies in atomic shells.....	36
	<i>BIBLIOGRAPHY</i> .....	36
 <i>Chapter 2. <b><u>DOSIMETRIC PRINCIPLES, QUANTITIES AND UNITS</u></b></i>		
<b>2.1.</b>	<b>INTRODUCTION.....</b>	<b>37</b>
<b>2.2.</b>	<b>PHOTON FLUENCE AND ENERGY FLUENCE .....</b>	<b>37</b>
<b>2.3.</b>	<b>KERMA .....</b>	<b>39</b>
<b>2.4.</b>	<b>CEMA .....</b>	<b>40</b>
<b>2.5.</b>	<b>ABSORBED DOSE.....</b>	<b>40</b>
<b>2.6.</b>	<b>STOPPING POWER.....</b>	<b>41</b>
<b>2.7.</b>	<b>RELATIONSHIPS BETWEEN DOSIMETRIC QUANTITIES .....</b>	<b>44</b>
2.7.1.	Energy fluence and kerma (photons).....	44
2.7.2.	Fluence and dose (electrons) .....	46
2.7.3.	Kerma and dose (charged particle equilibrium) .....	47
2.7.4.	Collision kerma and exposure .....	49
<b>2.8.</b>	<b>CAVITY THEORY .....</b>	<b>50</b>
2.8.1.	Bragg-Gray cavity theory .....	50
2.8.2.	Spencer-Attix cavity theory.....	51
2.8.3.	Considerations in the application of cavity theory to ionisation chamber calibration and dosimetry protocols.....	53
2.8.4.	Large cavities in photon beams .....	54
2.8.5.	Burlin cavity theory for photon beams .....	55
2.8.6.	Stopping power ratios.....	56
	<i>BIBLIOGRAPHY</i> .....	58
 <i>Chapter 3. <b><u>RADIATION DOSIMETERS</u></b></i>		
<b>3.1.</b>	<b>INTRODUCTION .....</b>	<b>59</b>
<b>3.2.</b>	<b>PROPERTIES OF DOSIMETERS .....</b>	<b>60</b>
3.2.1.	Accuracy and precision .....	60
3.2.2.	Linearity .....	62
3.2.3.	Dose rate dependence .....	62
3.2.4.	Energy dependence.....	63
3.2.5.	Directional dependence.....	63
3.2.6.	Spatial resolution and physical size.....	63
3.2.7.	Readout convenience.....	64
3.2.8.	Convenience of use.....	64
<b>3.3.</b>	<b>IONISATION CHAMBER DOSIMETRY SYSTEMS.....</b>	<b>64</b>

3.3.1.	Chambers and electrometers .....	64
3.3.2.	Cylindrical (thimble type) ionisation chambers.....	66
3.3.3.	Parallel-plate (plane-parallel) ionisation chambers .....	66
3.3.4.	Brachytherapy chambers .....	67
3.3.5.	Extrapolation chambers.....	68
<b>3.4.</b>	<b>FILM DOSIMETRY .....</b>	<b>68</b>
3.4.1.	Radiographic film .....	68
3.4.2.	Radiochromic film .....	71
<b>3.5.</b>	<b>LUMINESCENCE DOSIMETRY .....</b>	<b>71</b>
3.5.1.	Thermoluminescence.....	72
3.5.2.	TLD systems.....	73
3.5.3.	OSL systems.....	75
<b>3.6.</b>	<b>SEMICONDUCTOR DOSIMETRY .....</b>	<b>75</b>
3.6.1.	Silicon diode dosimetry systems .....	75
3.6.2.	MOSFET dosimeter.....	76
<b>3.7.</b>	<b>OTHER DOSIMETRY SYSTEMS .....</b>	<b>77</b>
3.7.1.	Alanine/EPR dosimetry system.....	77
3.7.2.	Plastic scintillator dosimetry system .....	77
3.7.3.	Diamond dosimeters.....	78
3.7.4.	Gel dosimetry systems.....	79
<b>3.8.</b>	<b>PRIMARY STANDARDS .....</b>	<b>80</b>
3.8.1.	Primary standard for <i>air-kerma in air</i> .....	80
3.8.2.	Primary standards for absorbed <i>dose-to-water</i> .....	80
3.8.3.	Ionometric standard for absorbed <i>dose-to-water</i> .....	81
3.8.4.	Chemical dosimetry standard for absorbed <i>dose-to-water</i> .....	81
3.8.5.	Calorimetric standard for absorbed <i>dose-to-water</i> .....	82
<b>3.9.</b>	<b>SUMMARY OF COMMONLY USED DOSIMETRY SYSTEMS.....</b>	<b>82</b>
	<i>BIBLIOGRAPHY</i> .....	84

Chapter 4. **RADIATION MONITORING INSTRUMENTS**

<b>4.1.</b>	<b>INTRODUCTION .....</b>	<b>85</b>
<b>4.2.</b>	<b>OPERATIONAL QUANTITIES FOR RADIATION MONITORING .....</b>	<b>85</b>
<b>4.3.</b>	<b>AREA SURVEY METERS .....</b>	<b>86</b>
4.3.1.	Ionisation chambers .....	88
4.3.2.	Proportional counters .....	88
4.3.3.	Neutron area survey meters .....	89
4.3.4.	GM counters .....	90
4.3.5.	Scintillator detectors .....	90

## *Table of Contents*

4.3.6.	Semiconductor detectors .....	90
4.3.7.	Commonly available features of area survey meters .....	91
4.3.8.	Calibration of survey meters .....	91
4.3.9.	Properties of survey meters .....	92
<b>4.4.</b>	<b>INDIVIDUAL MONITORING .....</b>	<b>94</b>
4.4.1.	Film badge .....	95
4.4.2.	Thermoluminescent dosimetry (TLD) badge .....	96
4.4.3.	Radiophotoluminescent (RPL) glass dosimetry systems .....	97
4.4.4.	Optically stimulated luminescence (OSL) systems .....	97
4.4.5.	Direct reading personal monitors .....	97
4.4.6.	Calibration .....	98
4.4.7.	Properties of personal monitors .....	99
	<i>BIBLIOGRAPHY</i> .....	101

## *Chapter 5. **MACHINES FOR EXTERNAL BEAM RADIOTHERAPY***

<b>5.1.</b>	<b>INTRODUCTION .....</b>	<b>103</b>
<b>5.2.</b>	<b>X-RAY BEAMS AND X-RAY UNITS .....</b>	<b>103</b>
5.2.1.	Characteristic x-rays .....	104
5.2.2.	Bremsstrahlung (continuous) x-rays .....	104
5.2.3.	X-ray targets .....	104
5.2.4.	Clinical x-ray beams .....	106
5.2.5.	X-ray beam quality specifiers .....	106
5.2.6.	X-ray machines for radiotherapy .....	107
<b>5.3.</b>	<b>GAMMA RAY BEAMS AND GAMMA RAY UNITS .....</b>	<b>108</b>
5.3.1.	Basic properties of gamma rays .....	108
5.3.2.	Teletherapy machines .....	109
5.3.3.	Teletherapy sources .....	109
5.3.4.	Teletherapy source housing .....	110
5.3.5.	Dose delivery with teletherapy machines .....	110
5.3.6.	Collimator and penumbra .....	111
<b>5.4.</b>	<b>PARTICLE ACCELERATORS .....</b>	<b>111</b>
5.4.1.	Betatron .....	112
5.4.2.	Cyclotron .....	112
5.4.3.	Microtron .....	113
<b>5.5.</b>	<b>LINEAR ACCELERATORS .....</b>	<b>114</b>
5.5.1.	Linac generations .....	114
5.5.2.	Safety of linac installations .....	115
5.5.3.	Components of modern linacs .....	115
5.5.4.	Configuration of modern linacs .....	116
5.5.5.	Injection system .....	118
5.5.6.	RF power generation system .....	118
5.5.7.	Accelerating waveguide .....	119

5.5.8.	Microwave power transmission .....	121
5.5.9.	Auxilliary system .....	121
5.5.10.	Electron beam transport .....	121
5.5.11.	Linac treatment head .....	122
5.5.12.	Production of clinical photon beams in a linac .....	123
5.5.13.	Beam collimation .....	123
5.5.14.	Production of clinical electron beams in a linac .....	124
5.5.15.	Dose monitoring system .....	125
<b>5.6.</b>	<b>RADIOTHERAPY WITH PROTONS, NEUTRONS AND HEAVY IONS .....</b>	<b>126</b>
<b>5.7.</b>	<b>SHIELDING CONSIDERATIONS .....</b>	<b>127</b>
<b>5.8.</b>	<b>COBALT-60 TELETHERAPY UNIT VERSUS LINAC .....</b>	<b>127</b>
<b>5.9.</b>	<b>SIMULATORS AND CT-SIMULATORS .....</b>	<b>130</b>
5.9.1.	Radiation therapy simulator .....	130
5.9.2.	CT-simulator.....	131
<b>5.10.</b>	<b>TRAINING REQUIREMENTS .....</b>	<b>132</b>
	<i>BIBLIOGRAPHY</i> .....	132

*Chapter 6. **EXTERNAL PHOTON BEAMS: PHYSICAL ASPECTS***

<b>6.1.</b>	<b>INTRODUCTION .....</b>	<b>133</b>
<b>6.2.</b>	<b>QUANTITIES USED IN DESCRIBING A PHOTON BEAM .....</b>	<b>133</b>
6.2.1.	Photon fluence and photon fluence rate .....	133
6.2.2.	Energy fluence and energy fluence rate .....	134
6.2.3.	Air-kerma in air .....	134
6.2.4.	Exposure in air.....	135
6.2.5.	Dose to small mass of medium in air .....	135
<b>6.3.</b>	<b>PHOTON BEAM SOURCES .....</b>	<b>137</b>
<b>6.4.</b>	<b>INVERSE SQUARE LAW .....</b>	<b>138</b>
<b>6.5.</b>	<b>PENETRATION OF PHOTON BEAMS INTO A PHANTOM OR PATIENT .....</b>	<b>139</b>
6.5.1.	Surface dose .....	141
6.5.2.	Buildup region .....	141
6.5.3.	Depth of dose maximum .....	142
6.5.4.	Exit dose .....	142
<b>6.6.</b>	<b>RADIATION TREATMENT PARAMETERS .....</b>	<b>142</b>
6.6.1.	Radiation beam field size .....	142
6.6.2.	Collimator factor .....	143

*Table of Contents*

6.6.3.	Peak-scatter factor <i>PSF</i> .....	144
6.6.4.	Relative dose factor <i>RDF</i> .....	146
<b>6.7.</b>	<b>CENTRAL AXIS DEPTH DOSES IN WATER: <i>SSD</i> SET-UP</b> .....	<b>148</b>
6.7.1.	Percentage depth dose <i>PDD</i> .....	148
6.7.2.	Scatter function <i>S</i> .....	151
<b>6.8.</b>	<b>CENTRAL AXIS DEPTH DOSES IN WATER: <i>SAD</i> SET-UP</b> .....	<b>152</b>
6.8.1.	Tissue-air ratio <i>TAR</i> .....	152
6.8.2.	Relationship between <i>TAR</i> and <i>PDD</i> .....	154
6.8.3.	Scatter-air ratio <i>SAR</i> .....	157
6.8.4.	Relationship between <i>SAR</i> and <i>S</i> .....	157
6.8.5.	Tissue-phantom ratio <i>TPR</i> and tissue-maximum ratio <i>TMR</i> .....	157
6.8.6.	Relationship between <i>TMR</i> and <i>PDD</i> .....	159
6.8.7.	Scatter-maximum ratio <i>SMR</i> .....	160
<b>6.9.</b>	<b>OFF-AXIS RATIOS AND BEAM PROFILES</b> .....	<b>161</b>
<b>6.10.</b>	<b>ISODOSE DISTRIBUTIONS IN WATER PHANTOMS</b> .....	<b>163</b>
<b>6.11.</b>	<b>ISODOSE DISTRIBUTIONS IN PATIENTS</b> .....	<b>165</b>
6.11.1.	Correction for irregular contours and oblique beam incidence .....	166
6.11.2.	Missing tissue compensation .....	168
6.11.3.	Corrections for tissue inhomogeneities .....	169
6.11.4.	Model-based algorithms .....	170
<b>6.12.</b>	<b>CLARKSON SEGMENTAL INTEGRATION</b> .....	<b>170</b>
<b>6.13.</b>	<b>RELATIVE MEASUREMENTS WITH IONISATION CHAMBERS</b> ...	<b>172</b>
<b>6.14.</b>	<b>DELIVERY OF DOSE WITH A SINGLE EXTERNAL BEAM</b> .....	<b>175</b>
<b>6.15.</b>	<b>EXAMPLE OF DOSE CALCULATION</b> .....	<b>176</b>
<b>6.16.</b>	<b>SHUTTER CORRECTION TIME</b> .....	<b>178</b>
	<i>BIBLIOGRAPHY</i> .....	178

Chapter 7. **CLINICAL TREATMENT PLANNING IN EXTERNAL PHOTON BEAM RADIOTHERAPY**

<b>7.1.</b>	<b>INTRODUCTION</b> .....	<b>179</b>
<b>7.2.</b>	<b>VOLUME DEFINITION</b> .....	<b>179</b>
7.2.1.	Gross tumor volume (GTV) .....	180
7.2.2.	Clinical target volume (CTV) .....	180
7.2.3.	Internal target volume (ITV) .....	181
7.2.4.	Planning target volume (PTV) .....	181
7.2.5.	Organ at risk (OAR) .....	181

<b>7.3.</b>	<b>DOSE SPECIFICATION .....</b>	<b>182</b>
<b>7.4.</b>	<b>PATIENT DATA ACQUISITION AND SIMULATION .....</b>	<b>182</b>
7.4.1.	Need for patient data .....	182
7.4.2.	Nature of patient data .....	183
7.4.3.	Treatment simulation .....	184
7.4.4.	Patient treatment position and immobilization devices .....	185
7.4.5.	Patient data requirements .....	186
7.4.6.	Conventional treatment simulation .....	188
7.4.7.	Computed tomography-based conventional treatment simulation ..	190
7.4.8.	Computed tomography-based virtual simulation .....	192
7.4.9.	Conventional simulator vs. CT simulator .....	196
7.4.10.	Magnetic resonance imaging for treatment planning .....	196
7.4.11.	Summary of simulation procedures .....	198
<b>7.5.</b>	<b>CLINICAL CONSIDERATIONS FOR PHOTON BEAMS .....</b>	<b>199</b>
7.5.1.	Isodose curves .....	199
7.5.2.	Wedge filters .....	199
7.5.3.	Bolus .....	202
7.5.4.	Compensating filters .....	202
7.5.5.	Corrections for contour irregularities .....	203
7.5.6.	Corrections for tissue inhomogeneities .....	205
7.5.7.	Beam combinations and clinical application .....	207
<b>7.6.</b>	<b>TREATMENT PLAN EVALUATION .....</b>	<b>211</b>
7.6.1.	Isodose curves .....	212
7.6.2.	Orthogonal planes and isodose surfaces .....	212
7.6.3.	Dose statistics .....	212
7.6.4.	Dose-volume histograms .....	213
7.6.5.	Treatment evaluation .....	215
<b>7.7.</b>	<b>TREATMENT TIME AND MONITOR UNIT CALCULATIONS .....</b>	<b>218</b>
7.7.1.	Treatment time and monitor unit calculations for fixed <i>SSD</i> set-ups	219
7.7.2.	Monitor units and treatment time calculations for isocentric set-ups	221
7.7.3.	Normalization of dose distributions .....	223
7.7.4.	Inclusion of output parameters in dose distribution .....	223
7.7.5.	Treatment time calculation for orthovoltage and cobalt-60 units ....	223
	<b>BIBLIOGRAPHY .....</b>	<b>224</b>

Chapter 8. **ELECTRON BEAMS: PHYSICAL AND CLINICAL ASPECTS**

<b>8.1.</b>	<b>CENTRAL AXIS DEPTH DOSE DISTRIBUTIONS IN WATER .....</b>	<b>225</b>
8.1.1.	General shape of depth dose curve .....	225
8.1.2.	Electron interactions with absorbing medium .....	226
8.1.3.	Inverse square law (virtual source position) .....	227
8.1.4.	Range concept (csda) .....	228

## Table of Contents

8.1.5.	Buildup region (depths between surface and $z_{max}$ )	230
8.1.6.	Dose distribution beyond $z_{max}$	231
<b>8.2.</b>	<b>DOSIMETRIC PARAMETERS OF ELECTRON BEAMS</b>	<b>231</b>
8.2.1.	Percentage depth dose	231
8.2.2.	Oblique beam incidence	233
8.2.3.	Output factors	234
8.2.4.	Therapeutic range $R_{90}$	235
8.2.5.	Electron beam energy specification	235
8.2.6.	Typical depth dose parameters as a function of energy	235
8.2.7.	Profiles and off-axis ratios	236
8.2.8.	Flatness and symmetry	236
<b>8.3.</b>	<b>CLINICAL CONSIDERATIONS IN ELECTRON BEAM THERAPY</b>	<b>237</b>
8.3.1.	Dose specification and reporting	237
8.3.2.	Bolus-electron range modifier	237
8.3.3.	Small field sizes	237
8.3.4.	Isodose curves	238
8.3.5.	Field shaping	239
8.3.6.	Irregular surface correction	241
8.3.7.	Inhomogeneity corrections	243
8.3.8.	Electron beam combinations	244
8.3.9.	Electron arc therapy	245
8.3.10.	Electron therapy treatment planning	247
	<i>BIBLIOGRAPHY</i>	248

## Chapter 9. **CALIBRATION OF PHOTON AND ELECTRON BEAMS**

<b>9.1.</b>	<b>INTRODUCTION</b>	<b>249</b>
9.1.1.	Calorimetry	250
9.1.2.	Fricke dosimetry	251
9.1.3.	Ionisation chamber dosimetry	251
9.1.4.	Reference dosimetry with ionisation chambers	252
9.1.5.	Clinical beam calibration and measurement chain	253
9.1.6.	Dosimetry protocols	254
<b>9.2.</b>	<b>IONISATION CHAMBER-BASED DOSIMETRY SYSTEMS</b>	<b>254</b>
9.2.1.	Ionisation chambers	254
9.2.2.	Electrometer and power supply	256
9.2.3.	Phantoms	256
<b>9.3.</b>	<b>CHAMBER SIGNAL CORRECTION FOR INFLUENCE QUANTITIES</b>	<b>257</b>
9.3.1.	Air temperature, pressure and humidity effects: $k_{T,P}$	257
9.3.2.	Chamber polarity effects: polarity correction factor $k_{pol}$	258
9.3.3.	Chamber voltage effects: recombination correction factor $k_{sat}$	259
9.3.4.	Chamber leakage currents	262
9.3.5.	Chamber stem effects	263

<b>9.4.</b>	<b>DETERMINATION OF ABSORBED DOSE USING CALIBRATED IONISATION CHAMBERS</b> .....	<b>264</b>
9.4.1.	<i>Air-kerma</i> -based protocols .....	264
9.4.2.	Absorbed <i>dose-to-water</i> -based protocols .....	266
<b>9.5.</b>	<b>STOPPING-POWER RATIOS</b> .....	<b>269</b>
9.5.1.	Stopping-power ratios for electron beams .....	269
9.5.2.	Stopping-power ratios for photon beams .....	270
<b>9.6.</b>	<b>MASS ENERGY–ABSORPTION COEFFICIENT RATIOS</b> .....	<b>270</b>
<b>9.7.</b>	<b>PERTURBATION CORRECTION FACTORS</b> .....	<b>271</b>
9.7.1.	Displacement perturbation factor $p_{\text{dis}}$ and effective point of Measurement .....	272
9.7.2.	The chamber wall perturbation factor $p_{\text{wall}}$ .....	273
9.7.3.	Central electrode perturbation $p_{\text{cel}}$ .....	275
9.7.4.	Cavity or fluence perturbation correction $p_{\text{cav}}$ .....	275
<b>9.8.</b>	<b>BEAM QUALITY SPECIFICATION</b> .....	<b>277</b>
9.8.1.	Beam quality specification for kilovoltage photon beams .....	277
9.8.2.	Beam quality specification for megavoltage photon beams .....	278
9.8.3.	Beam quality specification for megavoltage electron beams .....	279
<b>9.9.</b>	<b>CALIBRATION OF MEGAVOLTAGE PHOTON AND ELECTRON BEAMS: PRACTICAL ASPECTS</b> .....	<b>282</b>
9.9.1.	Calibration of megavoltage photon beams based upon <i>air-kerma in air</i> calibration coefficient $N_{\text{K,Co}}$ .....	282
9.9.2.	Calibration of megavoltage photon beams based on <i>dose-to-water</i> calibration coefficient $N_{\text{D,w,Co}}$ .....	283
9.9.3.	Calibration of megavoltage electron beams based upon <i>air-kerma in air</i> calibration coefficient $N_{\text{K,Co}}$ .....	284
9.9.4.	Calibration of high-energy electron beams based upon <i>dose-to-water</i> calibration coefficient $N_{\text{D,w,Co}}$ .....	285
<b>9.10.</b>	<b>KILOVOLTAGE DOSIMETRY</b> .....	<b>286</b>
9.10.1.	Specificities of kilovoltage beams .....	287
9.10.2.	The <i>air-kerma</i> -based in-phantom calibration method (medium energies) .....	288
9.10.3.	The <i>air-kerma</i> -based backscatter method (low and medium photon energies) .....	288
9.10.4.	<i>Air-kerma</i> in air-based calibration method for very low energies ...	289
9.10.5.	Absorbed dose to water-based calibration method .....	290
<b>9.11.</b>	<b>ERROR AND UNCERTAINTY ANALYSIS FOR IONISATION CHAMBER MEASUREMENTS</b> .....	<b>290</b>
9.11.1.	Errors and uncertainties .....	290



## *Table of Contents*

9.11.2.	Classification of uncertainties .....	291
9.11.3.	Uncertainties in the calibration chain .....	291
	<i>BIBLIOGRAPHY</i> .....	291

## *Chapter 10. ACCEPTANCE TESTS AND COMMISSIONING*

<b>10.1.</b>	<b>INTRODUCTION</b> .....	<b>293</b>
<b>10.2.</b>	<b>MEASUREMENT EQUIPMENT</b> .....	<b>293</b>
10.2.1.	Radiation survey equipment .....	293
10.2.2.	Ionometric dosimetry equipment .....	293
10.2.3.	Film.....	294
10.2.4.	Diodes .....	294
10.2.5.	Phantoms .....	294
<b>10.3.</b>	<b>ACCEPTANCE TESTS</b> .....	<b>295</b>
10.3.1.	Safety checks .....	296
10.3.2.	Mechanical checks .....	297
10.3.3.	Dosimetry measurements .....	301
<b>10.4.</b>	<b>COMMISSIONING</b> .....	<b>304</b>
10.4.1.	Photon beam measurements .....	304
10.4.2.	Electron beam measurements .....	310
<b>10.5.</b>	<b>TIME REQUIRED FOR COMMISSIONING</b> .....	<b>315</b>
	<i>BIBLIOGRAPHY</i> .....	316

## *Chapter 11. COMPUTERIZED TREATMENT PLANNING SYSTEMS FOR EXTERNAL BEAM RADIOTHERAPY*

<b>11.1.</b>	<b>INTRODUCTION</b> .....	<b>317</b>
<b>11.2.</b>	<b>SYSTEM HARDWARE</b> .....	<b>318</b>
11.2.1.	Treatment planning system hardware .....	318
11.2.2.	Treatment planning system configurations .....	319
<b>11.3.</b>	<b>SYSTEM SOFTWARE AND CALCULATION ALGORITHMS</b> .....	<b>319</b>
11.3.1.	Calculation algorithms .....	320
11.3.2.	Beam modifiers .....	322
11.3.3.	Heterogeneity corrections .....	324
11.3.4.	Image display and dose volume histograms .....	324
11.3.5.	Optimization .....	325
11.3.6.	Record and verify (RV) systems .....	325
11.3.7.	Biological modeling .....	326
<b>11.4.</b>	<b>DATA ACQUISITION AND ENTRY</b> .....	<b>326</b>

11.4.1.	Machine data .....	326
11.4.2.	Beam data acquisition and entry .....	327
11.4.3.	Patient data .....	328
<b>11.5.</b>	<b>COMMISSIONING AND QUALITY ASSURANCE .....</b>	<b>329</b>
11.5.1.	Errors .....	329
11.5.2.	Verification .....	329
11.5.3.	Spot checks .....	330
11.5.4.	Normalization and beam weighting .....	330
11.5.5.	Dose volume histograms and optimization .....	331
11.5.6.	Training and documentation .....	331
11.5.7.	Scheduled quality assurance .....	331
<b>11.6.</b>	<b>SPECIAL CONSIDERATIONS .....</b>	<b>332</b>
	<i>BIBLIOGRAPHY</i> .....	333

Chapter 12. **QUALITY ASSURANCE OF EXTERNAL BEAM RADIOTHERAPY**

<b>12.1.</b>	<b>INTRODUCTION .....</b>	<b>335</b>
12.1.1.	Definitions .....	335
12.1.2.	The need for quality assurance in radiotherapy .....	336
12.1.3.	Requirements on accuracy in radiotherapy .....	336
12.1.4.	Accidents in radiotherapy .....	338
<b>12.2.</b>	<b>MANAGING A QA PROGRAMME .....</b>	<b>340</b>
12.2.1.	Multidisciplinary radiotherapy team .....	340
12.2.2.	Quality system/comprehensive QA programme .....	342
<b>12.3.</b>	<b>QUALITY ASSURANCE PROGRAMME FOR EQUIPMENT .....</b>	<b>343</b>
12.3.1.	The structure of an equipment QA programme .....	344
12.3.2.	Uncertainties, tolerances and action levels .....	347
12.3.3.	QA programme for cobalt-60 teletherapy machines .....	348
12.3.4.	QA programme for linear accelerators .....	350
12.3.5.	QA programme for treatment simulators .....	352
12.3.6.	QA programme for CT scanners and CT-simulation .....	353
12.3.7.	QA programme for treatment planning systems .....	354
12.3.8.	QA programme for test equipment .....	356
<b>12.4.</b>	<b>TREATMENT DELIVERY .....</b>	<b>357</b>
12.4.1.	Patient charts .....	357
12.4.2.	Portal imaging .....	358
12.4.3.	<i>In-vivo</i> dose measurements.....	361
12.4.4.	Record-and-verify systems.....	365
<b>12.5.</b>	<b>QUALITY AUDIT .....</b>	<b>366</b>
12.5.1.	Definition .....	366
12.5.2.	Practical quality audit modalities .....	366

*Table of Contents*

12.5.3. What should be reviewed in a quality audit visit? ..... 366  
*BIBLIOGRAPHY* ..... 367

Chapter 13. **BRACHYTHERAPY: PHYSICAL AND CLINICAL ASPECTS**

**13.1. INTRODUCTION** ..... **371**

**13.2. PHOTON SOURCE CHARACTERISTICS** ..... **374**

13.2.1. Practical considerations ..... 374

13.2.2. Physical characteristics of some photon-emitting  
brachytherapy sources..... 374

13.2.3. Mechanical source characteristics ..... 375

13.2.4. Source specification..... 376

13.2.5. Specification of gamma ray sources..... 376

13.2.6. Specification of beta ray sources ..... 378

**13.3. CLINICAL USE AND DOSIMETRY SYSTEMS** ..... **378**

13.3.1. Gynecology ..... 378

13.3.2. Interstitial brachytherapy ..... 379

13.3.3. Remote afterloading systems ..... 380

13.3.4. Permanent prostate implants ..... 381

13.3.5. Eye plaques ..... 382

13.3.6. Intravascular brachytherapy ..... 383

**13.4. DOSE SPECIFICATION AND REPORTING** ..... **383**

13.4.1. Intracavitary treatments (ICRU Report 38) ..... 383

13.4.2. Interstitial treatments (ICRU Report 58) ..... 384

**13.5. DOSE DISTRIBUTIONS AROUND SOURCES** ..... **384**

13.5.1. AAPM TG-43 algorithm ..... 384

13.5.2. Other calculation methods for point sources ..... 386

13.5.3. Linear sources ..... 388

**13.6. DOSE CALCULATION PROCEDURES** ..... **389**

13.6.1. Manual dose calculations ..... 389

13.6.2. Computerized treatment planning ..... 390

13.6.3. Calculation of treatment time ..... 391

**13.7. COMMISSIONING OF BRACHYTHERAPY COMPUTER  
TREATMENT PLANNING SYSTEMS** ..... **392**

13.7.1. Check of the reconstruction procedure ..... 392

13.7.2. Check of consistency between quantities and units ..... 392

13.7.3. Computer vs. manual dose calculation for single source ..... 392

13.7.4. Check of decay corrections ..... 393

**13.8. SOURCE COMMISSIONING** ..... **393**

13.8.1. Wipe tests ..... 393

13.8.2.	Autoradiography and uniformity checks of activity .....	393
13.8.3.	Calibration chain .....	393
<b>13.9.</b>	<b>QUALITY ASSURANCE .....</b>	<b>394</b>
13.9.1.	Constancy check of calibrated dosimeter .....	394
13.9.2.	Regular checks of sources and applicators .....	394
13.9.3.	Checks of source positioning with afterloading devices .....	394
13.9.4.	Radiation monitoring around patients .....	394
13.9.5.	Quality management programme .....	395
<b>13.10.</b>	<b>BRACHYTHERAPY VERSUS EXTERNAL BEAM THERAPY .....</b>	<b>395</b>
	<i>BIBLIOGRAPHY</i> .....	395

Chapter 14. **BASIC RADIOBIOLOGY**

<b>14.1.</b>	<b>INTRODUCTION .....</b>	<b>397</b>
<b>14.2.</b>	<b>CLASSIFICATION OF RADIATIONS IN RADIOBIOLOGY .....</b>	<b>398</b>
<b>14.3.</b>	<b>CELL CYCLE AND CELL DEATH .....</b>	<b>399</b>
<b>14.4.</b>	<b>IRRADIATION OF CELLS .....</b>	<b>399</b>
14.4.1.	Direct action in cell damage by radiation .....	399
14.4.2.	Indirect action of cell damage by radiation .....	400
14.4.3.	Fate of irradiated cells .....	400
<b>14.5.</b>	<b>TYPE OF RADIATION DAMAGE .....</b>	<b>401</b>
14.5.1.	Time scale .....	401
14.5.2.	Classification of radiation damage .....	401
14.5.3.	Somatic and genetic effects .....	401
14.5.4.	Stochastic and deterministic effects .....	402
14.5.5.	Acute vs. chronic effects .....	402
14.5.6.	Total body radiation response .....	402
14.5.7.	Fetal irradiation .....	403
<b>14.6.</b>	<b>CELL SURVIVAL CURVES .....</b>	<b>403</b>
<b>14.7.</b>	<b>DOSE-RESPONSE CURVES .....</b>	<b>405</b>
<b>14.8.</b>	<b>MEASUREMENT OF RADIATION DAMAGE IN TISSUE .....</b>	<b>407</b>
<b>14.9.</b>	<b>NORMAL AND TUMOR CELLS: THERAPEUTIC RATIO .....</b>	<b>407</b>
<b>14.10.</b>	<b>OXYGEN EFFECT .....</b>	<b>408</b>
<b>14.11.</b>	<b>RELATIVE BIOLOGICAL EFFECTIVENESS .....</b>	<b>410</b>
<b>14.12.</b>	<b>DOSE RATE AND FRACTIONATION .....</b>	<b>411</b>

<b>14.13. RADIOPROTECTORS AND RADIOSENSITIZERS .....</b>	<b>412</b>
<i>BIBLIOGRAPHY .....</i>	<i>412</i>
<i>Chapter 15. <b><u>SPECIAL PROCEDURES AND TECHNIQUES IN RADIOTHERAPY</u></b></i>	
<b>15.1. INTRODUCTION .....</b>	<b>413</b>
<b>15.2. STEREOTACTIC IRRADIATION .....</b>	<b>413</b>
15.2.1. Physical and clinical requirements for radiosurgery .....	414
15.2.2. Diseases treated with stereotactic irradiation .....	415
15.2.3. Equipment used for stereotactic radiosurgery .....	415
15.2.4. Historical development .....	415
15.2.5. Radiosurgical techniques .....	416
15.2.6. Uncertainty in radiosurgical dose delivery .....	419
15.2.7. Dose prescription and dose fractionation .....	419
15.2.8. Commissioning of radiosurgical equipment .....	420
15.2.9. Quality assurance in radiosurgery .....	420
15.2.10. Gamma knife versus linac-based radiosurgery .....	421
15.2.11. Frameless stereotaxy .....	421
<b>15.3. TOTAL BODY IRRADIATION (TBI) .....</b>	<b>422</b>
15.3.1. Clinical TBI categories .....	422
15.3.2. Diseases treated with TBI .....	422
15.3.3. Technical aspects of TBI .....	423
15.3.4. TBI techniques .....	423
15.3.5. Dose prescription point .....	423
15.3.6. Commissioning of TBI procedure .....	423
15.3.7. Test of TBI dosimetry protocol .....	424
15.3.8. Quality assurance in TBI .....	424
<b>15.4. TOTAL SKIN ELECTRON IRRADIATION (TSEI) .....</b>	<b>427</b>
15.4.1. Physical and clinical requirements for TSEI .....	427
15.4.2. Current TSEI techniques .....	428
15.4.3. Selection of TSEI technique .....	429
15.4.4. Dose calibration point .....	429
15.4.5. Skin dose rate at the dose prescription point .....	429
15.4.6. Commissioning of TSEI procedure .....	429
15.4.7. Measurement of clinical TSEI dose distributions .....	430
15.4.8. Quality assurance in TSEI .....	430
<b>15.5. INTRAOPERATIVE RADIOTHERAPY (IORT) .....</b>	<b>431</b>
15.5.1. Physical and clinical requirements for IORT .....	431
15.5.2. IORT radiation modalities and techniques .....	431
15.5.3. Commissioning an IORT programme .....	432
15.5.4. Quality assurance in IORT .....	432
<b>15.6. ENDOCAVITARY RECTAL IRRADIATION .....</b>	<b>433</b>

15.6.1.	Physical and clinical requirements for endorectal irradiation .....	433
15.6.2.	Endorectal treatment technique .....	434
15.6.3.	Quality assurance in endorectal treatments .....	434
<b>15.7.</b>	<b>CONFORMAL RADIOTHERAPY .....</b>	<b>435</b>
15.7.1.	Basic aspects of conformal radiotherapy .....	435
15.7.2.	Multileaf collimators .....	435
15.7.3.	Acceptance testing of MLCs .....	436
15.7.4.	Commissioning of MLCs .....	437
15.7.5.	Quality assurance programme for MLCs .....	437
15.7.6.	Intensity Modulated Radiation Therapy (IMRT) .....	437
15.7.7.	Commissioning of IMRT systems .....	438
15.7.8.	Quality assurance for IMRT systems .....	439
15.7.9.	Dose verification for IMRT treatment plans .....	440
<b>15.8.</b>	<b>IMAGE-GUIDED RADIATION THERAPY .....</b>	<b>440</b>
15.8.1.	The BAT system .....	441
15.8.2.	The ExacTrac ultrasonic module .....	441
15.8.3.	CT Primatom .....	441
15.8.4.	Tomotherapy .....	442
15.8.5.	CyberKnife .....	442
<b>15.9.</b>	<b>RESPIRATORY GATED RADIATION THERAPY .....</b>	<b>443</b>
<b>15.10.</b>	<b>PET/CT SCANNERS AND PET/CT IMAGE FUSION .....</b>	<b>444</b>
	<i>BIBLIOGRAPHY</i> .....	446

Chapter 16. **RADIATION PROTECTION AND SAFETY IN RADIOTHERAPY**

<b>16.1.</b>	<b>INTRODUCTION .....</b>	<b>447</b>
<b>16.2.</b>	<b>RADIATION EFFECTS .....</b>	<b>448</b>
16.2.1.	Deterministic effects.....	448
16.2.2.	Stochastic effects .....	448
16.2.3.	Effects on embryo and fetus .....	448
<b>16.3.</b>	<b>INTERNATIONAL CONSENSUS AND RADIATION SAFETY STANDARDS .....</b>	<b>449</b>
<b>16.4.</b>	<b>TYPES OF RADIATION EXPOSURE .....</b>	<b>449</b>
<b>16.5.</b>	<b>QUANTITIES AND UNITS USED IN RADIATION PROTECTION ....</b>	<b>450</b>
16.5.1.	Physical quantities .....	450
16.5.2.	Radiation protection quantities .....	451
16.5.3.	Operational quantities .....	454
<b>16.6.</b>	<b>BASIC FRAMEWORK OF RADIATION PROTECTION .....</b>	<b>455</b>

## *Table of Contents*

<b>16.7. GOVERNMENTAL REGULATION AND INFRASTRUCTURE</b>	<b>456</b>
<b>16.8. SCOPE OF THE BASIC SAFETY STANDARDS</b>	<b>457</b>
<b>16.9. RESPONSIBILITY FOR IMPLEMENTATION OF THE BASIC SAFETY STANDARDS REQUIREMENTS</b>	<b>457</b>
<b>16.10. SAFETY IN THE DESIGN OF RADIATION SOURCES AND EQUIPMENT</b>	<b>458</b>
16.10.1. Equipment	458
16.10.2. Sealed sources	460
16.10.3. Safety in design of facilities and ancillary equipment	461
<b>16.11. SAFETY ASSOCIATED WITH ACCEPTANCE TESTS, COMMISSIONING AND OPERATION</b>	<b>464</b>
16.11.1. Safe operation of external beam radiotherapy	465
16.11.2. Safe operation of brachytherapy	465
<b>16.12. SECURITY OF SOURCES</b>	<b>467</b>
<b>16.13. OCCUPATIONAL EXPOSURE</b>	<b>468</b>
16.13.1. Responsibilities and conditions of service	468
16.13.2. The use of dose constraints in radiotherapy	469
16.13.3. Investigation levels for staff exposure in radiotherapy	469
16.13.4. Pregnant workers	469
16.13.5. Classification of areas	470
16.13.6. Local rules and supervision	470
16.13.7. Protective equipment and tools	470
16.13.8. Individual monitoring and exposure assessment	471
16.13.9. Monitoring the workplace	471
16.13.10. Health surveillance	472
16.13.11. Records	472
<b>16.14. MEDICAL EXPOSURE</b>	<b>473</b>
16.14.1. Responsibilities for medical exposure	473
16.14.2. Justification of medical exposure	473
16.14.3. Optimization of exposure and protection	474
16.14.4. Calibration of radiotherapy sources and machines	474
16.14.5. Clinical dosimetry	476
16.14.6. Quality assurance for medical exposures	476
16.14.7. Constraints for comforters and visitors	477
16.14.8. Discharge of patients	478
16.14.9. Investigation of accidental medical exposure	478
<b>16.15. PUBLIC EXPOSURE</b>	<b>479</b>
16.15.1. Responsibilities	479
16.15.2. Access control for visitors	479
16.15.3. Radioactive waste and sources no longer in use	479
16.15.4. Monitoring of public exposure	479

<b>16.16. POTENTIAL EXPOSURE AND EMERGENCY PLANS</b> .....	<b>479</b>
16.16.1. Potential exposure and safety assessment .....	480
16.16.2. Mitigation of consequences: emergency plans .....	480
<b>16.17. GENERAL SHIELDING CALCULATIONS</b> .....	<b>482</b>
16.17.1. Step one: design dose at occupied areas (annual dose and weekly dose) .....	483
16.17.2. Step two: calculation of the radiation field ( <i>air-kerma in air</i> ) in the occupied area without shielding .....	484
16.17.3. Step three: attenuation by shielding barriers .....	484
<b>16.18. TYPICAL LINEAR ACCELERATOR INSTALLATION</b> .....	<b>486</b>
16.18.1. Workload .....	488
16.18.2. Calculation of primary barrier transmission factor $B_{\text{pri}}$ .....	488
16.18.3. Calculation of the scatter barrier transmission factor $B_{\text{scat}}$ .....	488
16.18.4. Calculation of the leakage barrier transmission factor $B_{\text{leak}}$ .....	489
16.18.5. Determination of barrier thickness .....	489
16.18.6. Consideration of neutron production in a high-energy linac .....	490
16.18.7. Door of a linear accelerator room .....	490
16.18.8. Other considerations .....	491
<b>16.19. SHEILDING DESIGN FOR BRACHYTHERAPY FACILITIES</b> .....	<b>491</b>
<i>BIBLIOGRAPHY</i> .....	492
 <b><i>LIST OF INTERNATIONAL ORGANISATIONS</i></b> .....	 <b>496</b>
 <b><i>ABBREVIATIONS AND ACRONYMS</i></b> .....	 <b>497</b>
 <b><i>LIST OF SYMBOLS</i></b> .....	 <b>501</b>
 <b><i>SUBJECT INDEX</i></b> .....	 <b>505</b>
 <b><i>BIBLIOGRAPHY ON RADIATION ONCOLOGY PHYSICS</i></b> .....	 <b>519</b>



This publication is aimed at students and teachers involved in programmes that train professionals for work in radiation oncology. It provides a comprehensive overview of the basic medical physics knowledge required in the form of a syllabus for modern radiation oncology. It will be particularly useful to graduate students and residents in medical physics programmes, to residents in radiation oncology, as well as to students in dosimetry and radiotherapy technology programmes. It will assist those preparing for their professional certification examinations in radiation oncology, medical physic...