ICRU REPORTS

The ICRU (originally known as the International X-Ray Unit Committee and later as the International Committee for Radiological Units) was conceived at the First International Congress of Radiology (ICR) in London in 1925 and officially came into being at ICR-2 in Stockholm in 1928. The primary objective was to propose a unit for measurement of radiation as applied in medicine. From 1950 the ICRU expanded its role significantly to embrace a wider field. Initially meetings were held every 3 years at ICR congresses (excluding the 13-year period encompassing World War II) with one physicist and one radiologist from each participating country having the right of attendance with the Chairman being nominated by the ICR host country. A permanent Commission was elected in 1953.

"This article contains the titles and summaries of various ICRU reports"

Report No. 94

Methods for Initial-Phase Assessment of Individual Doses Following Acute Exposures to Ionizing Radiation

Executive Summary

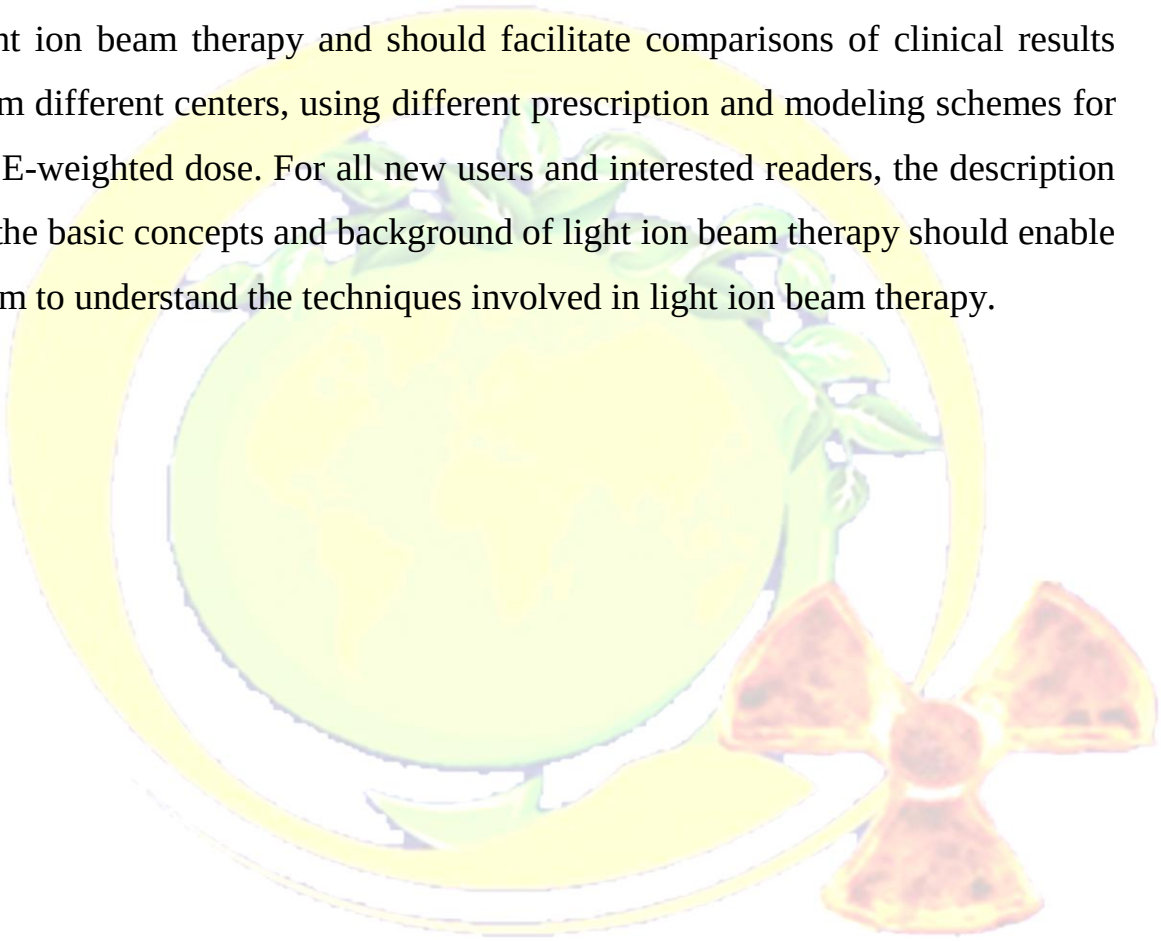
Dosimetry methods for use in dose assessment for individuals following acute exposure to radiation are described. Primary methods include biodosimetry and physical dosimetry techniques, while additional supplementary methods are bioassays, neutron activation, and radiation field mapping. Biodosimetry methods include the established techniques of dicentric chromosome assay, cytokinesis-block micronucleus assay, translocation analysis by fluorescent in-situ hybridization, remature chromosome condensation, and the γ-H2AX assay. Emerging techniques include RNA expression-based, protein-based, and metabolomic-based assays. Physical dosimetry methods include electron paramagnetic resonance and the luminescence-based techniques of thermoluminescence and optically stimulated luminescence. Electron paramagnetic resonance methods are used to assess absorbed dose in biologically derived materials, such as bone, teeth, and keratinous tissue, as well as non-biologically derived materials such as sugars, glasses, and polymeric materials used in fabrics and other personal items.

Report No. 93

Prescribing, Recording, and Reporting Light Ion Beam Therapy

Executive Summary

This Report should be an important and useful reference for all practitioners in light ion beam therapy and should facilitate comparisons of clinical results from different centers, using different prescription and modeling schemes for RBE-weighted dose. For all new users and interested readers, the description of the basic concepts and background of light ion beam therapy should enable them to understand the techniques involved in light ion beam therapy.



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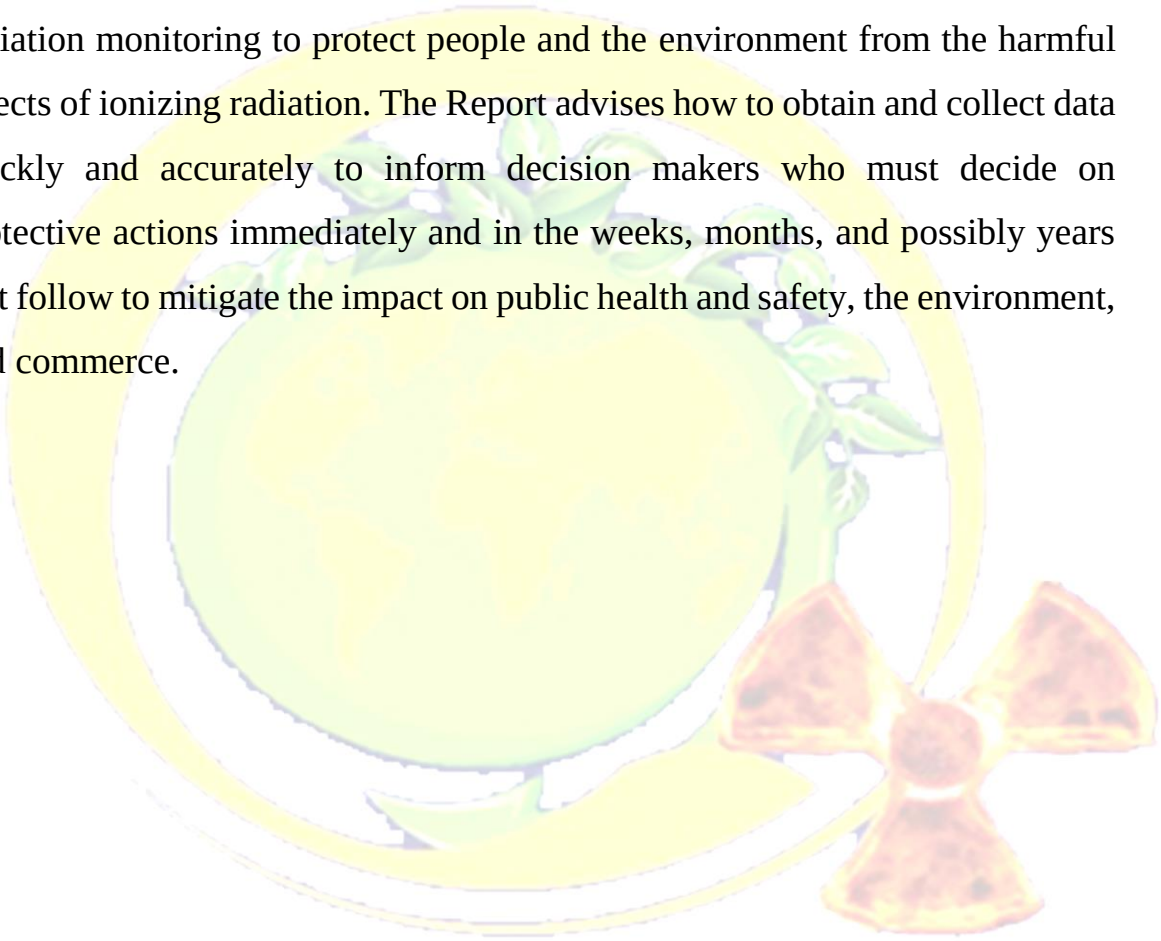
Report No. 92

Radiation Monitoring for Protection of the Public after Major Releases of Radionuclides to the Environment

Executive Summary

The objective of the Report is to provide detailed practical guidance on radiation monitoring to protect people and the environment from the harmful effects of ionizing radiation. The Report advises how to obtain and collect data quickly and accurately to inform decision makers who must decide on protective actions immediately and in the weeks, months, and possibly years that follow to mitigate the impact on public health and safety, the environment, and commerce.



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Report No. 91

Prescribing, Recording, and Reporting of Stereotactic Treatments with Small Photon Beams

Executive Summary

Rapid developments in imaging and radiation-delivery technology have fueled the application of small photon beams in stereotactic radiation therapy (SRT). Historically, stereotaxy referred to the use of a three-dimensional coordinate system to localize intracranial targets and has been more recently extensively developed in extracranial clinical situations. SRT involves stereotactic localization techniques combined with the delivery of multiple small photon fields in a few high-dose fractions. In SRT, the therapeutic ratio is optimized through delivery of highly conformal absorbed dose distributions with steep dose fall-off ensuring optimal absorbed dose in the target volume combined with minimal normal-tissue irradiation. Consistent with previous ICRU Reports 50 (ICRU, 1993), 62, (ICRU, 1999), and 83, (ICRU, 2010), this Report recommends a strict definition of target volumes (GTV, CTV) by reviewing imaging modalities used in clinical practice. This Report covers fundamentals of small-field dosimetry, treatment-planning algorithms, commissioning, and quality assurance for the existing delivery systems, as well as the role of image guidance during delivery. Finally, it recommends a framework for prescribing, recording, and reporting stereotactic radiotherapy, and covers most of the pathologies eligible for stereotactic delivery (malignant and non-malignant).

Report No. 90

Key Data For Ionizing-Radiation Dosimetry: Measurement Standards And Applications

Executive Summary

Ionizing radiation dosimetry is used to describe those measurements or calculations that provide information on the energy deposited by the interaction of ionizing radiation with matter. Radiation dosimetry is of importance in several areas including radiation therapy, radiation protection, and the industrial use of radiation. Several techniques have been developed for measuring energy deposition, with ionization chambers and calorimeters being the most important. These techniques form the basis of primary measurement standards for ionizing radiation, and these primary standards require values and uncertainty estimates for certain key parameters used to relate the result of measurement to the desired quantity.

Report No. 89

Prescribing, Recording, and Reporting Brachytherapy for Cancer of the Cervix

Executive Summary

This ICRU/GEC-ESTRO report starts with the essential background, including a clinical introduction, historical and current techniques including the concepts of volumetric imaging for cervix cancer. One key element is the four-dimensional adaptive target concept at certain time points during treatment by clinical examination and imaging. For the rectum, bladder, sigmoid, adjacent bowel, and vagina in addition to contours including the entire organ the report emphasizes the presence of different morbidity endpoints and related substructures within the organ. The radiobiology chapter explains the limitations of the linearquadratic model, but encourages the use of the EQD2 concept as the current best option for treatment planning and overall dose reporting. A detailed concept is recommended to report dose and volume parameters related to contours and reference points. The report includes detailed chapters on treatment planning, especially for three-dimensional volumetric approach, but also the underlying concepts of dosimetry which remains essential for volumetric and radiography-based planning.

Report No. 88

Measurement and Reporting of Radon Exposures

Executive Summary

Lung cancer risk caused by the inhalation of radon (222Rn) and its short-lived progeny is related to lung dose, which cannot be directly measured. The only measurable parameters which allow the determining of lung doses are the radon and radon progeny activity concentrations and related size distributions. Although lung cancers are caused by the inhaled short-lived radon progeny and not by the radon gas, it is the radon gas which is commonly measured and not its progeny. Since radon gas measurements are much easier to carry out, require less expensive equipment and are especially suited for long-term measurements, the report focuses on the measurement of the radon gas for specific exposure conditions in homes and workplaces.

Report No. 87

Radiation Dosimetry and Image Quality Assessment in Computed Tomography

Executive Summary

Computed tomography has experienced a number of significant technological advances over the past decade, and these have had pronounced impacts on the accuracy of radiation dosimetry and the assessment of image quality. After reviewing CT technology and clinical applications, this Report describes and discusses existing dosimetry methods and then presents new methods for radiation dosimetry, including the evaluation of beam quality, and measurement of CT-scanner output in air and in phantoms. Many of the proposed dosemetric quantities can be measured quickly using a real-time ionization chamber, which is introduced here. Traditional measurements of image quality for computed tomography rely upon simple and subjective observations. A more rigorous approach is proposed, including routine use of the modulationtransfer function for describing spatial resolution along all axes, and of the noise-power spectrum for describing the noise amplitude and texture properties of CT images. This Report focuses on new but practical methods for the assessment of radiation dose and image quality for CT scanners.

Report No. 86

Quantification and Reporting of Low-Dose and Other Heterogeneous Exposures

Executive Summary

This Report recommends that, in cases in which energy deposition is likely to be heterogeneous, a detailed description of the radiation field, with an appropriate description of the irradiated system, should be given. The complete description of the radiation is the energy distribution of the particle radiance as a function of time and particle type. However, simplified descriptions such as the distribution of fluence rate, the probability density of lineal energy and the event rate, or even the absorbed-dose rate and radiation quality are appropriate descriptions of the irradiation in many cases.

Report No. 85

Fundamental Quantities and Units for Ionizing Radiation

Executive Summary

Definitions of fundamental quantities, and their units, for ionizing radiation are given, which represent the recommendation of the International Commission on Radiation Units and Measurements (ICRU).

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Report No. 83

Prescribing, Recording, and Reporting Intensity-Modulated Photon-Beam Therapy (IMRT)

Executive Summary

The present report provides the information necessary to standardize techniques and procedures and to harmonize the prescribing, recording, and reporting of IMRT where possible with those of other modalities. Applicable concepts and recommendations in other ICRU reports concerning radiation therapy are adopted and extended where required. Clinical examples of IMRT are provided to illustrate the recommendations of prescribing, recording, and reporting that are contained in this report. As the present report describes in some detail the physical, technical, treatment planning and clinical aspects of IMRT, it should be a useful reference for current practitioners and should also provide new and potential users, as well as other interested readers, with the basic background to enable them to understand the techniques involved and the requirements for implementing IMRT.

Report No. 82

Mammography - Assessment of Image Quality

Executive Summary

This Report is intended for healthcare policy decision makers, radiologists, referring physicians, medical physicists and medical imaging radiographers (technologists). Mammography is widely used in many countries, with the potential of a large benefit in reducing mortality from breast cancer and facilitating the management of this disease. The principles discussed in this report should be helpful to the reader in helping to provide this benefit while reducing radiation-related risks to acceptable levels.

Report No. 81

Quantitative Aspects of Bone Densitometry

Executive Summary

This ICRU report systematically addresses the quantities and units used in bone densitometry utilizing both x-ray and ultrasound techniques. For x-ray techniques the most important quantities are bone mineral density (BMD) and bone mineral mass (BMM), and for ultrasound techniques the speed of sound (SOS) or velocity of sound (VOS), and broadband ultrasonic attenuation (BUA). In the first section of the report these quantities are precisely defined in accordance with the SI system and ISO standards and ambiguities in their current use in the literature are addressed. For example, it is suggested that areal bone mineral density measured with dual energy x-ray absorptiometry (DXA) be indicated by a subscript "a" (BMDa) to differentiate it from the true volumetric quantity BMD measured by quantitative computed tomography (QCT). Another suggestion is the renaming of bone mineral content (BMC) to bone mineral mass (BMM).

Report No. 80

Dosimetry Systems for Use in Radiation Processing

Executive Summary

The present Report examines the dosimetry performed in the industrial applications of radiation processing.

A brief description is given of the main radiation-processing applications using photon or electron-beam irradiations, the dosimetry performed for these applications, and the traceability of these absorbed-dose measurements to standards maintained by national laboratories. The properties of nine dosimetry systems, some reference standard dosimetry systems and some used for routine monitoring, are then examined in detail. The descriptions include the reaction mechanisms and the historical background leading to the present systems. Some additional dosimetry systems now in use and some potential new systems are described in less detail.

Report No. 79

Receiver Operating Characteristic (ROC) Analysis in Medical Imaging

Executive Summary

ROC parameters such as the area under the ROC curve and the index of detectability are useful descriptors of diagnostic performance because they are independent of the bias produced by the variation in the application of decision criteria by the observers. The report describes the basic decision model, the approach to ROC curve-fitting and current experimental and statistical methodology. The multi-reader multi-case (MRMC) approach that utilizes the jackknife technique for resampling cases and the analysis of variance (ANOVA) for the final analysis is stressed. Newer advances that are in progress including analyses of location (LROC) and analysis of cases with multiple lesions (FROC) are included. The report provides some practical guidelines for the design and execution of clinical and laboratory ROC studies. There is a bibliography of historically important and currently relevant publications. Appendices contains web addresses where ROC analysis software can be obtained, an example of an experiment done using ROC analysis, and an example of a statistical power calculation.

Report No. 78

Prescribing, Recording, and Reporting Proton-Beam Therapy

Executive Summary

As the present report describes in some detail the radiobiological, physical, technical, treatment planning and clinical aspects of proton beam therapy, it should be a useful reference for current practitioners and should also provide new and potential users, as well as other interested readers, with the basic background to enable them to understand the techniques involved in proton therapy.

Report No. 76

Measurement Quality Assurance for Ionizing Radiation Dosimetry

Executive Summary

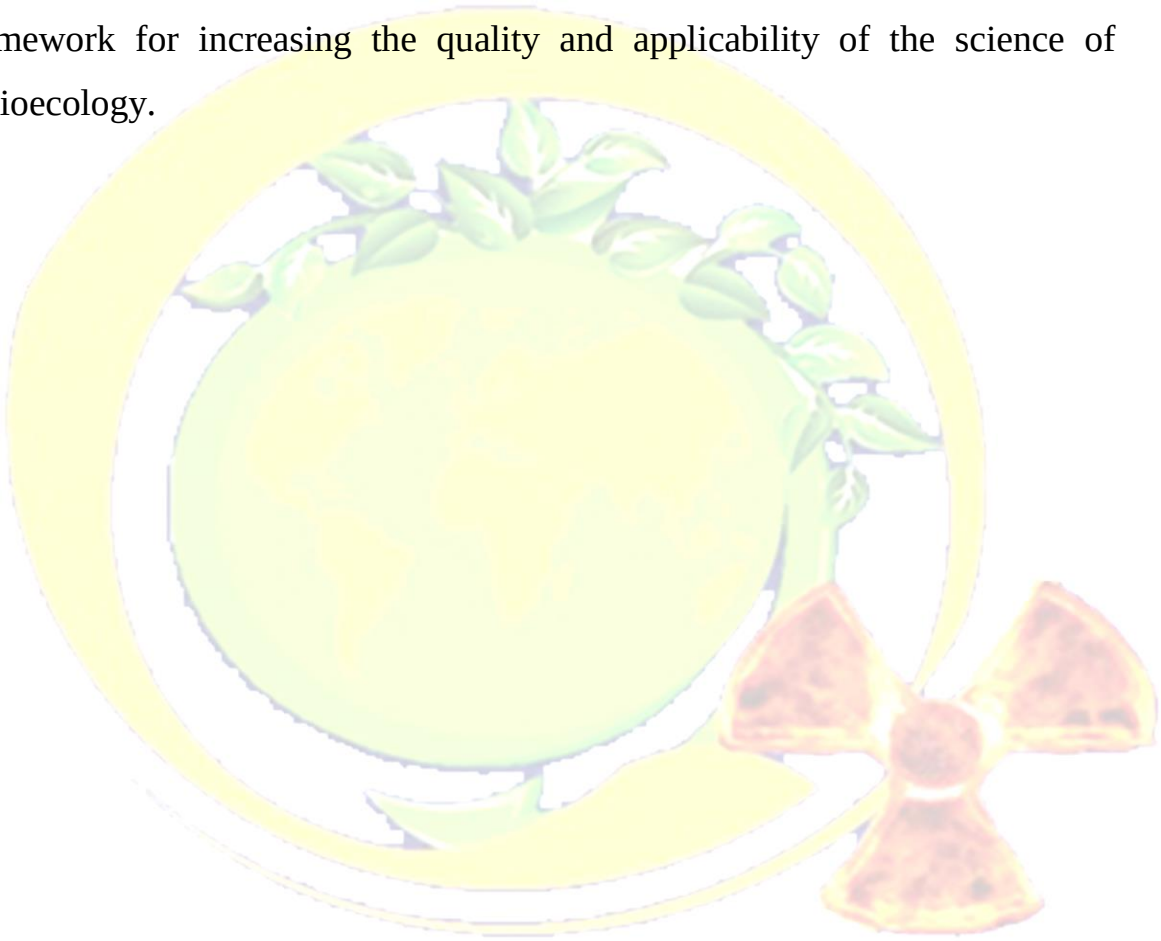
The report is intended for individuals and organizations responsible for calibrations and measurements of ionizing radiation. It is also expected to be of interest to agencies responsible for regulating radiological activities. The information and guidance provided should be useful to personnel making radiation measurements as well as to the users of calibration services. The report discusses methods for establishing and maintaining a measurement quality assurance program. The report describes the methods that are necessary to manage the quality of ionizing-radiation measurements and calibrations. These methods are applicable to all types of radiation that are currently used in medical physics, radiation protection, industrial applications, and environmental measurements. The types of radiation covered include photons, electrons, neutrons, and charged particles. Quantities considered include absorbed dose, air kerma, fluence, and dose equivalent.

Report No. 75

Sampling of Radionuclides in the Environment

Executive Summary

The goal of this report is to provide a broader and improved conceptual framework for increasing the quality and applicability of the science of radioecology.



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Report No. 74

Patient Dosimetry for X Rays used in Medical Imaging

Executive Summary

This report presents specifications of x-ray beams and quantities,and units for dose measurement and calculation in medical x-rayimaging, including application-specific quantities, and newsymbols. It addresses measurement methods for normalizationquantities and for quantities recommended for the establishmentand use of diagnostic reference levels. It presents methodsfor determining organ and tissue doses as well as doses in localizedregions of organs and tissues, including detailed informationon dose-conversion coefficients for x-ray imaging fields. Thisis the first ICRU report dealing with methods for patient dosimetryof x rays used in medical imaging. Whereas some of the dosimetricconcepts and techniques used in radiotherapy have been successfullyemployed for medical imaging using x rays, additional dosimetricquantities and measurement methods are required for patientdosimetry associated with procedures such as radiography, fluoroscopy,CT, and mammography.

Report No. 72

Dosimetry of Beta Rays and Low-Energy Photons for Brachytherapy with Sealed Sources

Executive Summary

This Report examines the dosimetry of beta-ray and low-energy photon-emitting sealed brachytherapy sources, specifically the following: (a) planar and concave sources of beta rays from 90Sr—90Y and 106Ru—106Rh, mainly used for ophthalmic plaques; (b) seed and wire sources of beta rays from 90Sr—90Y, 90Y, and 32P, and shell sources of 32P, for applications in intravascular brachytherapy; and (c) seed sources of low-energy photons from 125I and 103Pd, for use in ophthalmic plaques and as interstitial implants.

Report No. 71

Prescribing, Recording, and Reporting Electron Beam Therapy

Executive Summary

ICRU Report 71, Prescribing, Recording, and Reporting Electron Beam Therapy. The Report extends the concepts and recommendations for photons contained in ICRU Reports 50 and 62 to electron beam therapy. Reflecting the similarities between electron and photon treatments, the section on volumes in the present Report is very similar to the section on volumes in Reports 50 and 62, but evolutionary clarifications applicable to both modalities are presented. The concepts of Gross Tumor Volume (GTV), Clinical Target Volume (CTV), Planning Target Volume (PTV), Organs at Risk (OARs) and Planning Organ at Risk Volume (PRV) are recalled, or refined, and new examples are given to illustrate these concepts.

Report No. 70

Image Quality in Chest Radiography

Executive Summary

This report describes many issues that are related to the quality of chest radiographic images. In so doing, it relies upon the very extensive literature on this topic, a topic that has been one of the most thoroughly studied in all of radiography. Strategies that are generally agreed to improve the quality of chest radiographs are described, as are approaches to the assessment of image quality.

Report No. 69

Direct Determination of the Body Content of Radionuclides

Executive Summary

Previous ICRU reports have dealt with the formulation and properties of tissue substitutes and phantoms that are used to calibrate in vivo measurement systems. This report provides guidance on the overall process of the direct measurement of radionuclides in the human body for radiation protection and medical applications.

It addresses the detectors and electronics used for the measurement; methods of background reduction and control; measurement geometries for whole body, partial body or organ counting; physical and mathematical calibration methods; data analysis; and quality assurance. It is directed to readers who need practical advice on the establishment and operation of direct measurement facilities.

Report No. 68

Retrospective Assessment of Exposure to Ionising Radiation

Executive Summary

Basic dose quantities used in dose reconstruction are defined. The following dose -reconstruction methods based on measurements performed for individual persons are reviewed: electron paramagnetic resonance (EPR) measurements with tooth enamel, analyses of dicentric chromosomes and chromosome translocations, counting of micronuclei in lymphocytes, somatic mutation assays, and measurements of radionuclide activities in the human body.

Report No. 67

Absorbed-Dose Specification in Nuclear Medicine

Executive Summary

A number of reasons have led to a reappraisal of dose specification for nuclear medicine. These include an appreciation of non-uniformities in the distribution of radioactivity in the body, at all levels, for even the most common diagnostic and therapeutic agents; an increasing need to deal with the complexities of varying dose rates; the imperative to provide individual rather than standardised dose estimates as targeted radio-nuclide therapy becomes more sophisticated; as well as improvements in technology.

This Report deals first with biological considerations that inform the rational use of radionuclide dosimetry. Radiobiological factors in the selection of radionuclides and tumour and normal-tissue doseâ€“responses are discussed. Then, the MIRD (medical internal radiation dose) approach to nuclear medical dosimetry, a robust method that has proven its clinical utility, is described. Following on is an elaboration of non-uniform distri-butions of radioactivity and of varying dose rates. Lastly, the Report deals with techniques and procedures for measuring time variant activity distributions, image fusion, patient specific dose computations, small-scale dosimetry, and the comparison of calculated and measured doses.

Report No. 65

Quantities, Units and Terms in Radioecology

Executive Summary

This Report provides the first comprehensive and authoritative set of definitions for quantities, units and terms used in the highly interdisciplinary field of radioecology. The scope of this report is the presentation of the primary quantities and terms that are used in studies of radionuclide transport in the environment and those used to help assess the effects of environmental radioactivity on plants, animals and humans.

The first section of the report defines the quantities frequently used in radioecology. Explanatory comments are provided, and special conditions that must be specified for the quantities to be fully understood are given. To encourage greater uniformity and to minimise confusion in this field, both the currently recommended and previously used names and symbols are given. The second section provides a glossary of scientific terms that are often used in radioecology. Many of these terms are common to one or more other scientific disciplines that have been applied to radioecology studies. A number of appendices are also included which provide common and scientific names of selected plant and animal species that are commonly studied in radioecology.

Report No. 64

Dosimetry of High-Energy Photon Beams Based on Standards of Absorbed Dose to Water

Executive Summary

This Report examines the methods by which absorbed dose to water can be determined for photon radiations with maximum energies from approximately to 1 MeV to 50 MeV, the beam qualities most commonly used for radiation therapy.

The Report is primarily concerned with methods of measurement for photon radiation, but many aspects are also relevant to the dosimetry of other therapeutic beams (high-energy electrons, protons, etc.). It deals with methods that are sufficiently precise and well established to be incorporated into the dosimetric measurement chain as primary standards (i.e., methods based on ionisation, radiation-induced chemical changes, and calorimetry using either graphite or water). The report discusses the primary dose standards used in several national standards laboratories and reviews the international comparisons that have been made. The report also describes the reference conditions that are suitable for establishing primary standards and provides a formalism for determining absorbed dose, including a discussion of correction factors needed under conditions other than those used to calibrate an instrument at the standards laboratory.

Report No. 63

Nuclear Data for Neutron and Proton Radiotherapy and for Radiation Protection

Executive Summary

This Report represents a departure for the ICRU in that it includes a compact disc carrying an extensive compilation of data. Included in this publication is a comprehensive tabulation of nuclear data especially relevant for medical, industrial, research, and protection applications. Extensive microscopic cross-sections for neutron and proton interaction with elements important to dosimetry, radiation transport, and industrial applications are provided. For each application, the granularity of the data tabulations reflects the anticipated needs.

Report No. 62

Prescribing, Recording and Reporting Photon Beam Therapy

Executive Summary

ICRU Report 62 provides recommendations on the volumes and absorbed doses that are important in prescribing, recording and reporting photon beam therapy, utilizing the new and improved irradiation techniques that have become available since the publication of ICRU Report 50 in 1993.

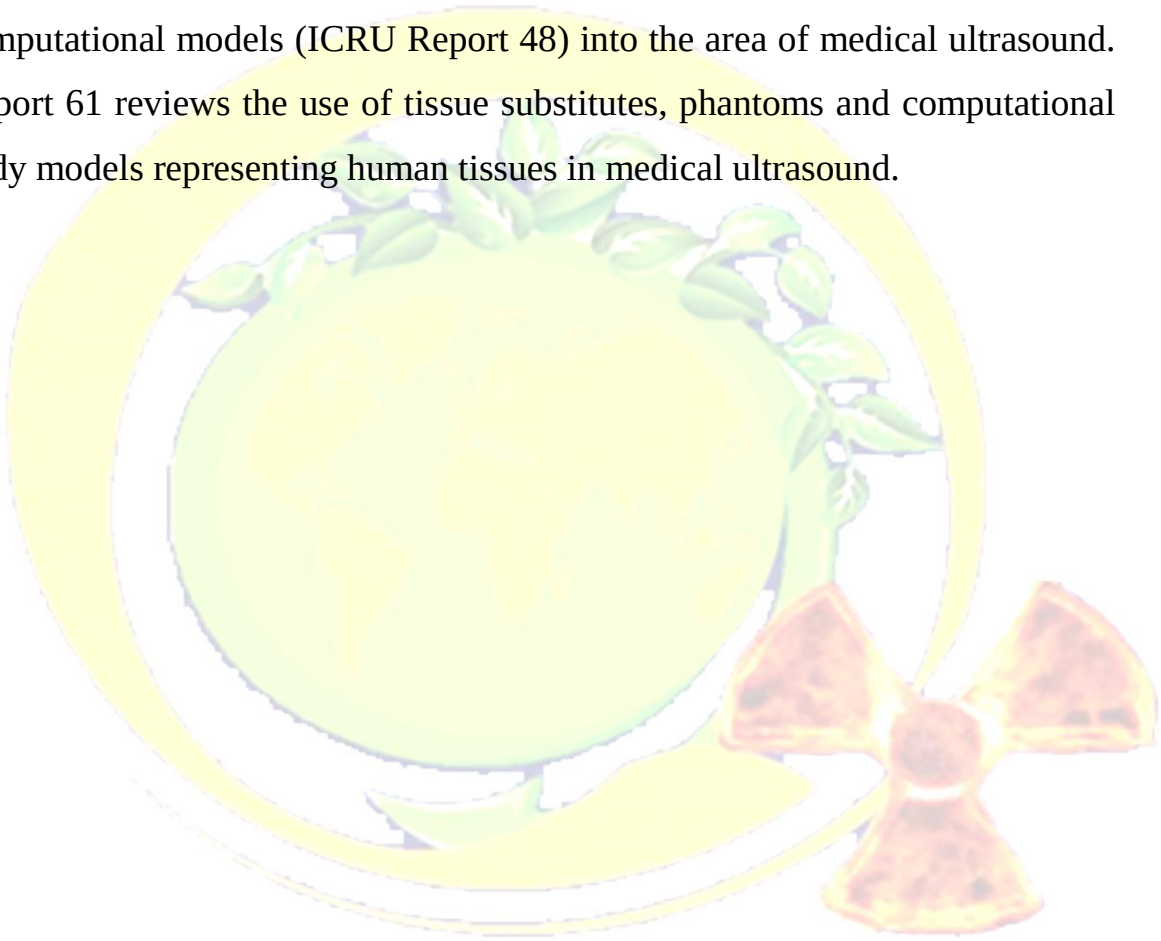
The new techniques rely on the ability of modern imaging procedures to provide more complete information on the location, shape and limits of target volumes and organs at risk. Margins around the target volumes become more critical in this situation and the Report addresses this question in some detail, introducing new concepts and refining previous recommendations.

Report No. 61

Tissues Substitutes, Phantoms and Computation Modelling in Medical Ultrasound

Executive Summary

This Report presents an expansion of previous ICRU work on phantoms and computational models (ICRU Report 48) into the area of medical ultrasound. Report 61 reviews the use of tissue substitutes, phantoms and computational body models representing human tissues in medical ultrasound.



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Report No. 60

Fundamental Quantities and Units for Ionizing Radiation

Executive Summary

This Report is the latest in a long series of ICRU documents providing definitions for quantities and units employed in radiation science. The Report supercedes Part A of ICRU report 33 dealing with quantities and units for general use. Part B of Report 33, covering quantities and units for use in radiation protection, was replaced in 1993 by ICRU Report 51, Quantities and Units in Radiation Protection Dosimetry.

Report 60 provides definitions for fundamental quantities employed in (1) radiometry, (2) specification of interaction coefficients, (3) dosimetry and (4) radioactivity. In addition to scalar quantities, the new Report also treats relevant vectorial quantities. A definition of cema is provided, a quantity for assessing energy lost by charged particles in a way analogous to the use of kerma for assessing the transfer of energy by uncharged particles.

Report No. 58

Dose and Volume Specification for Reporting Interstitial Therapy

Executive Summary

This Report is the latest in a series of ICRU Reports treating matters of dose specification. The Commission previously issued ICRU Report 38, Dose and Volume Specification for Reporting Intracavitary Therapy in Gynecology and ICRU Report 50, Prescribing, Recording and Reporting Photon Beam Therapy.

Report 58 focuses, of course, on absorbed dose specification for reporting interstitial therapy, but many of the concepts developed in the report are also applicable to certain other kinds of brachytherapy. The Report develops a common language for reporting which is based on existing concepts. The intent is to provide a means for specifying dose and volume in a way that can be closely related to the outcome of treatment and that will be generally understood.

Report No. 57

Conversion Coefficients for use in Radiological Protection against External Radiation

Executive Summary

ICRU Report 57 is the product of a long collaboration between the ICRU and the International Commission on Radiological Protection (ICRP). The report was prepared by a Joint Task Group of the two Commissions, underwent separate review by each Commission and has been published in the series of each Commission.

Report No. 56

Dosimetry of External Beta Rays for Radiation Protection

Executive Summary

This Report recognizes that the general aim of beta-ray dosimetry in radiation protection is to provide dosimetric information that will help in keeping any harmful effects of beta rays within acceptable limits and that, in the event of serious over-exposure, will assist medical treatment and prognosis.

Report No. 55

Secondary Electron Spectra from Charged Particle Interactions

Executive Summary

ICRU Report No. 55 provides a comprehensive guide to quantitative information about emission of secondary electrons in collisions of fast electrons, protons, alpha particles, and heavier ions with free atoms and molecules and with condensed matter. Explanations of the various mechanisms of ionization are given.

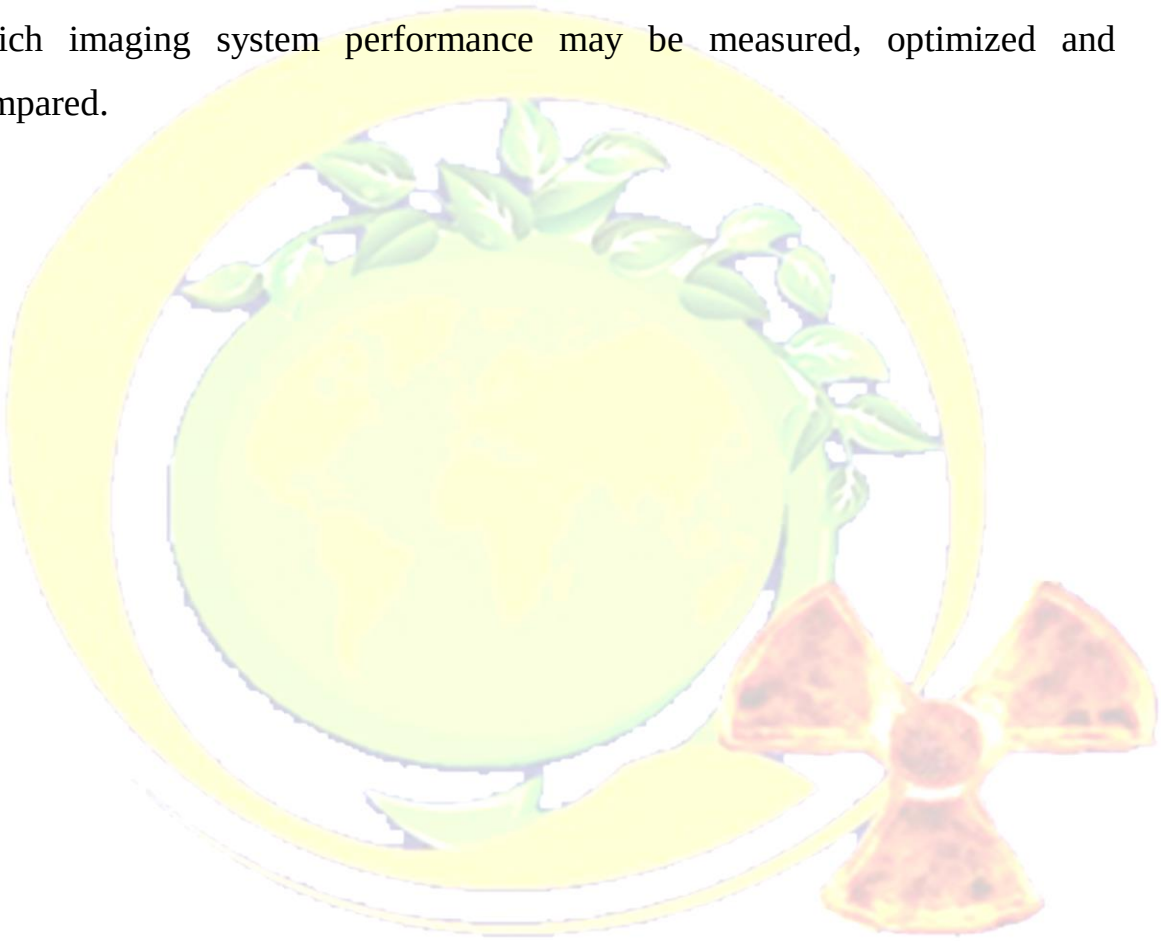
Experimental methods are described, and theoretical techniques are presented for determining total cross sections as well as cross sections differential in the ejection angle and energy of the secondary electrons. The semi-empirical and analytical models given enable the user to make rapid calculations of certain cross sections. Some applications of secondary electron spectra to radiological problems are also described. Data are available for impacts by electrons at energies from a few keV up to 10 keV, for incident protons from a few keV up to 5 MeV, and for heavier particles up to 1000 MeV. Methods are described for extrapolating cross section data to higher energies. The wide variety of targets reviewed include atoms (H, He, Ne, Ar, Kr, Xe, and Hg), molecules (H2 , N2, O2, CO2, H2O, CH4, C2H2, C3H8, C6H6, CH3NH2) and solids (C, Al, Pb, and Au). Some of the calculational methods can be used for all targets for which basic data, such as ionization potentials, are available.

Report No. 54

Medical Imaging - The Assessment of Image Quality

Executive Summary

This Report proposes a framework, based on statistical decision theory, within which imaging system performance may be measured, optimized and compared.



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Report No. 53

Gamma-Ray Spectrometry in the Environment

Executive Summary

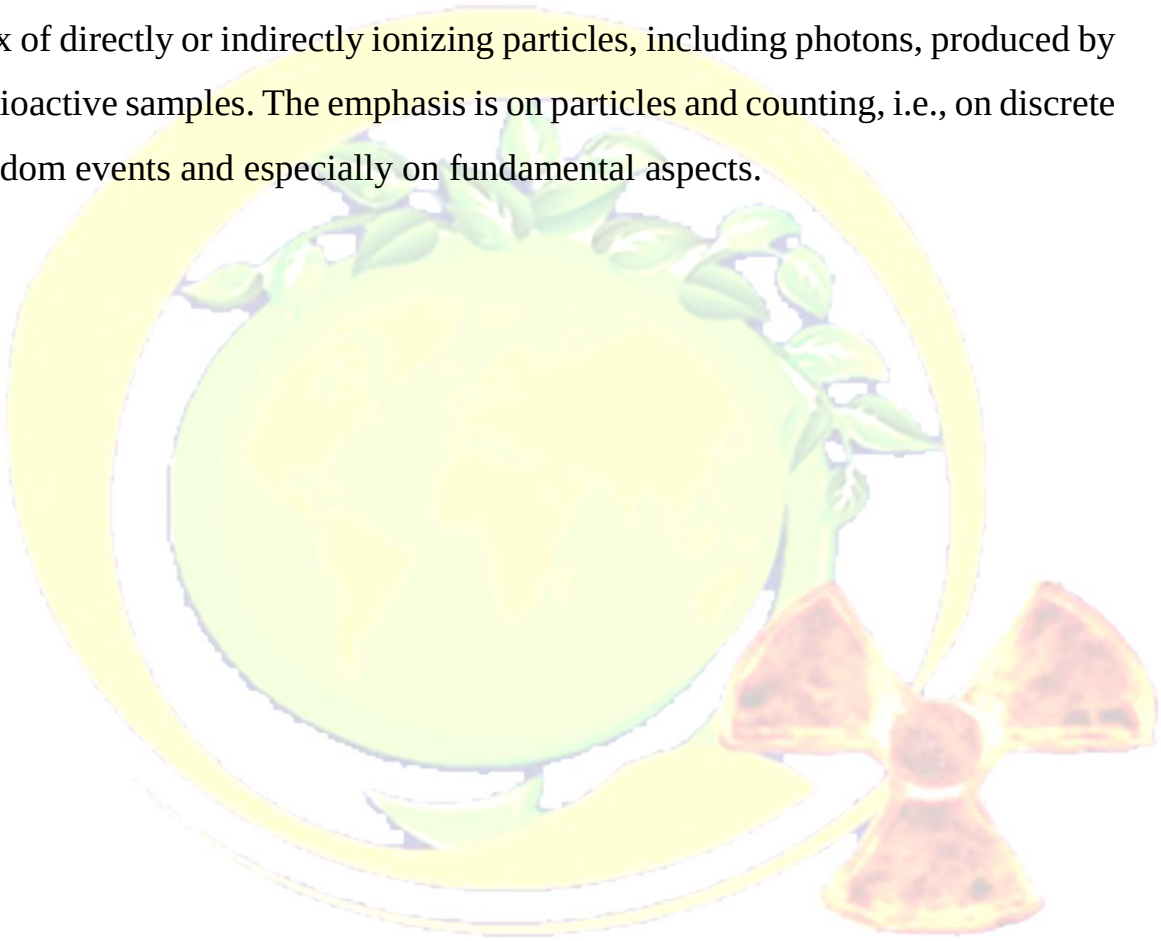
ICRU Report No. 53 was prepared in recognition of the fact that methods for quickly assessing radionuclides in the environment have become increasingly important, particularly in connection with accidental releases from nuclear facilities. Gamma-ray spectrometry, based on the measurement of the spectral distribution of the photon fluence, is used for the determination of activity levels in the ground or in the air and of radionuclide-specific dose quantities.

Report No. 52

Particle Counting in Radioactivity Measurements

Executive Summary

This Report describes the principles involved in counting, or measuring, the flux of directly or indirectly ionizing particles, including photons, produced by radioactive samples. The emphasis is on particles and counting, i.e., on discrete random events and especially on fundamental aspects.



Report No. 51

Quantities and Units in Radiation Protection Dosimetry

Executive Summary

ICRU Report No. 51 supersedes part B of ICRU Report 33 entitled "Quantities and Units for Use in Radiation Protection". Since that report was published in 1980, much discussion has taken place on this subject. This led to the introduction of operational quantities for the specification of dose equivalents for area and individual monitoring for external radiations, as discussed in ICRU Reports 39 (1985), 43 (1988) and 47 (1992).

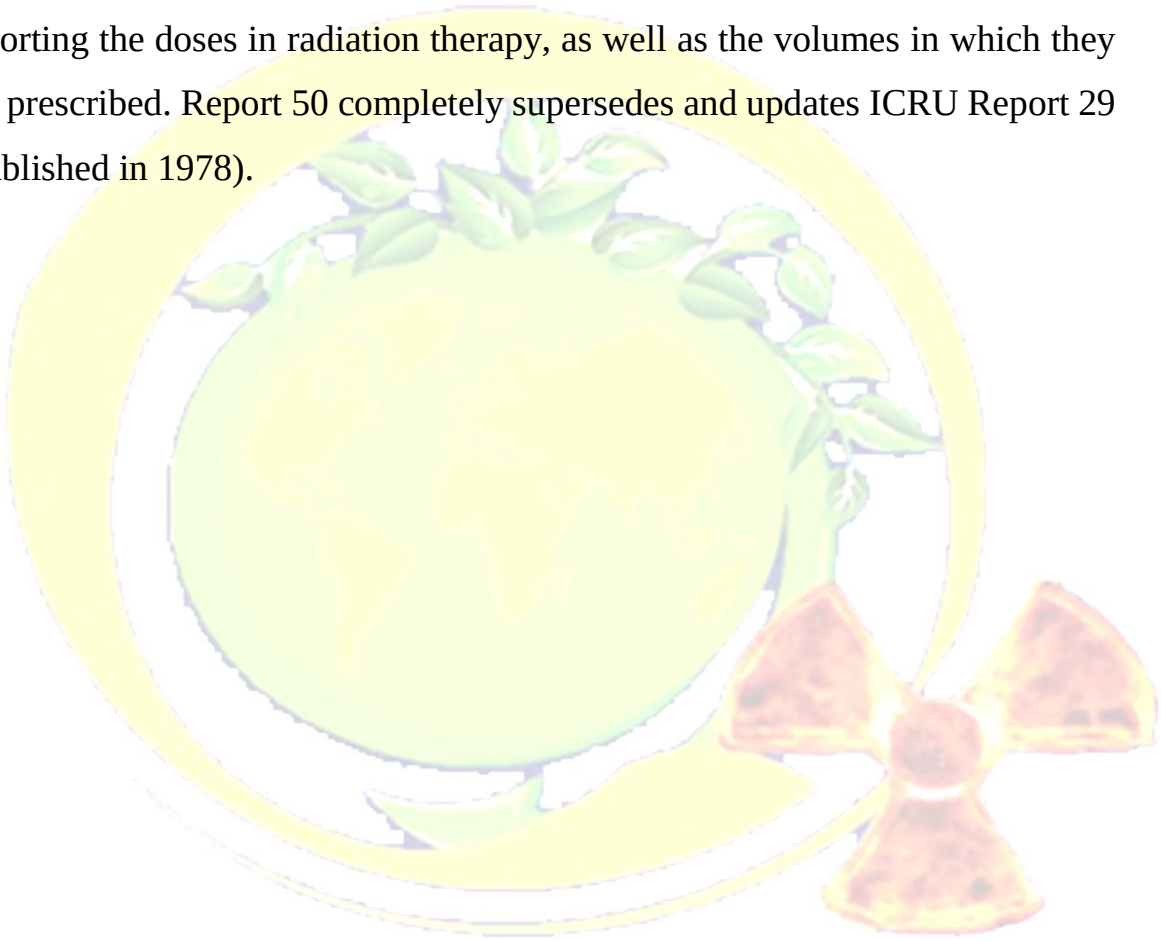
The determination of quantities relevant to radiation protection often entails significant uncertainties, and approximations will need to be introduced. However, it is essential that the quantities employed be unambiguously defined, and that the approximations be clearly identified. ICRU Report 51 aims to provide, in a revised format, a single clear presentation of a coherent system of quantities and units for use in radiation protection dosimetry. It is intended for purposes of measurement and calculation in the assessment of compliance with dose limitations. Thus, the report is divided into two parts. Part I deals with the quantities and units defined for use in measurements and calculations, whereas Part II relates to quantities based on mean values which are used for limitation purposes.

Report No. 50

Prescribing, Recording, and Reporting Photon Beam Therapy

Executive Summary

This Report seeks to promote the use of acommon language for specifying and reporting the doses in radiation therapy, as well as the volumes in which they are prescribed. Report 50 completely supersedes and updates ICRU Report 29 (published in 1978).



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Report No. 49

Stopping Power and Ranges for Protons and Alpha Particles

Executive Summary

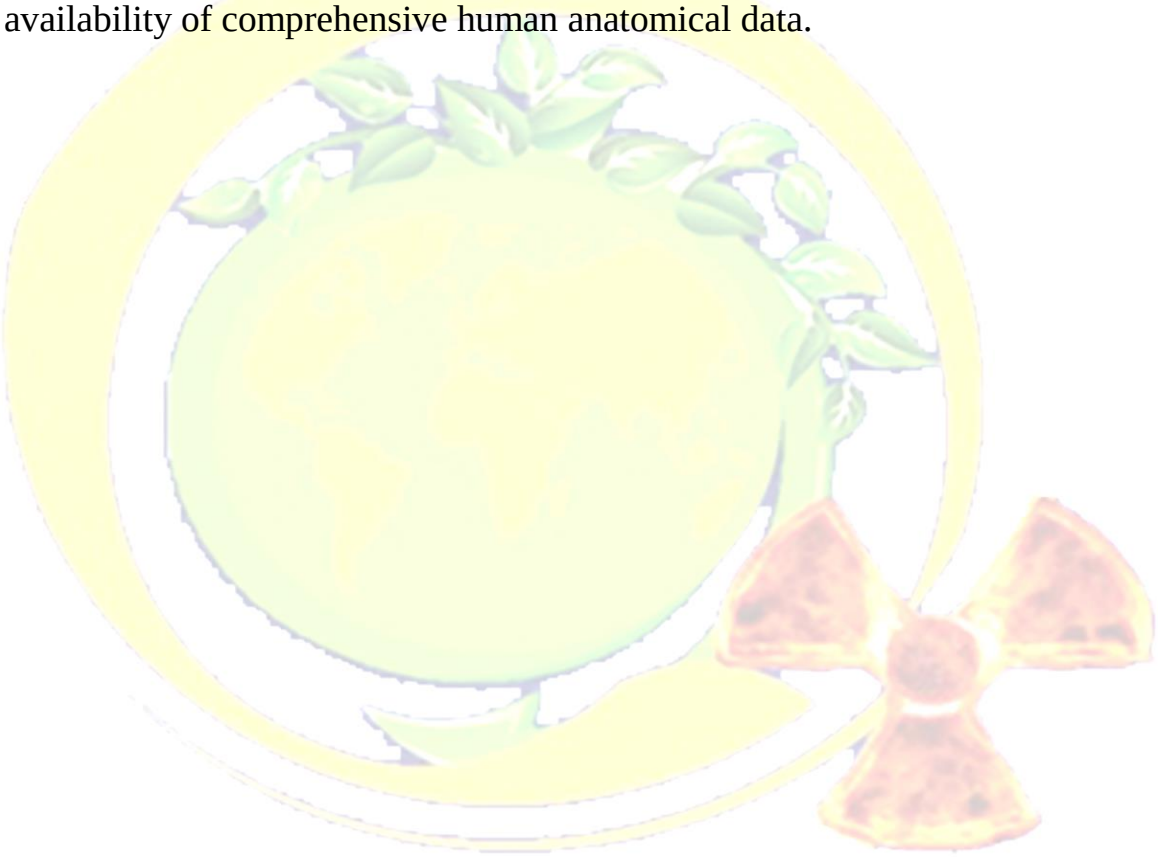
ICRU Report No. 49 is another report in the series providing compilations of data important in various aspects of radiation assessment. Stopping powers for electrons and positrons were provided in ICRU Report 37 published in 1984. ICRU Report 49 provides comparable information for protons and alpha particles. The Report encompasses the tablulation of stopping powers and ranges for 73 materials and covers the energy ranges 1 keV to 10,000 MeV for protons, and up to 1000 MeV for alpha particles. Included are collision (electronic), nuclear, and total stopping powers, csda ranges, and detour factors. The materials covered are those of interest in radiological physics and biomedical dosimetry and range through elements such as He, Al, Fe, Au and U, and compounds and mixtures such as acetylene, muscle (skeletal), polyethylene and tissue equivalent gas. The stopping power tables cover more than 140 pages in the Report. Also covered in some detail in the Report are matters such as calculation of electronic stopping powers of protons and alpha particles at high energies according to Bethe's theory with various corrections. The use of experimental information for electronic stopping powers at low energies is also treated. Sections of the Report also cover calculation of nuclear stopping powers and comparison of tabulated values with experimental results. Finally, the Report also provides concise descriptions of methods used for stopping power measurements.

Report No. 48

Phantoms and Computational Models in Therapy, Diagnosis and Protection

Executive Summary

This Report was prepared in recognition of the fact that the development of realistic body phantoms and computational models is strongly dependent on the availability of comprehensive human anatomical data.



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Report No. 47

Measurement of Dose Equivalents from External Photon and Electron Radiations

Executive Summary

ICRU Report No. 47 is the third report in the series treating determination of dose equivalent. The first two reports of the series, ICRU Report 39, Determination of Dose Equivalents from External Radiation Sources, and ICRU Report 43, Determination of Dose Equivalents from External Radiation Sources - Part II, provided the grounds for the Commission's selection of the quantities and the basis for their definition. ICRU Report 47 gives guidance on the design, calibration and use of instruments required to implement the recommended system of dose determination. Covered in the report are principles of measurement, operational quantities, characteristics of instruments, calibrations and the impact of new operational quantities on the design of future instrumentation. Among the instruments characterized are ionization chambers, proportional counters, Geiger-MÃ¼ller counters, scintillation detectors, semiconductor detectors, photographic films, thermoluminescent dosimeters, thermally stimulated exoelectron emission detectors and photoluminescent detectors. An appendix provides conversion factors for dose equivalent quantities.

Report No. 46

Photon, Electron, Proton and Neutron Interaction Data for Body Tissues

Executive Summary

This Report is a companion volume expanding on the material covered in ICRU Report 44, Tissue Substitutes in Radiation Dosimetry and Measurement. The new report provides specific information on representative sets of tissues that illustrates the effects of tissue composition variation on the pertinent radiation interaction quantities. It includes photon, electron, proton and neutron interaction data for body tissues, covering the age interval from fetus to adult. Soft tissues, skeletal tissues and calculi are considered. Soft tissues include adipose tissues, brain, breast (including component tissues), heart, liver and muscles (skeletal), which includes the connective tissue, blood vessels, blood, lymph, etc., generally associated with striated muscle. Skeletal tissues and calculi include cortical bone, breast calcifications, cholesterol gallstones and various types of urinary (renal) stones. The first tabulation in the report provides elemental composition, mass and electron densities of the complete set of body tissues. This is followed with a tabulation (184 pages) of the photon, electron, proton, and neutron interaction data. These include mass attenuation coefficients, electron mass stopping powers, electron mass scattering powers, proton stopping powers and neutron kerma factors.

Report No. 44

Tissue Substitutes in Radiation Dosimetry and Measurement

Executive Summary

This Report was prepared in recognition of the fact that the measurement of absorbed doses within and around the irradiated body tissues necessitates the use of carefully selected materials from which phantoms and radiation detectors can be constructed. The use of such materials permits determination of absorbed doses when information on the energy and nature of the charged particles at the point of interest is incomplete or fragmentary. To make an appropriate selection of material for such purposes, it is necessary to have information on the characteristics of tissue substitutes that affect radiation interaction and the report provides these. Since the required degree of agreement between the measured and "actual" absorbed doses depends upon the intended application of the data, the individual specialties employing tissue substitutes are surveyed in the report, including phantom and detector materials used in radiotherapy, radiodiagnosis, radiation protection and radiobiology.

Report No. 43

Determination of Dose Equivalents from External Radiation Sources-Part II

Executive Summary

ICRU Report No. 43 is the second in a three-report series produced by the ICRU to provide guidance on the practical determination of dose equivalents from external radiation sources. The first of the series, ICRU Report 39, Determination of Dose Equivalents from External Radiation Sources, provided definitions of quantities to be employed in radiological protection monitoring, including the ambient dose equivalent, the directional dose equivalent, the individual dose equivalent penetrating, and the individual dose equivalent superficial. Report 43 provides the grounds for the Commission=s selection of these quantities and the basis for their definition.

Report No. 41

Modulation Transfer Function of Screen- Film Systems

Executive Summary

This Report reviews and describes various concepts used in the analysis of the physical aspects of radiographic image quality for the screen-film systems used in diagnostic radiology. Concepts are described generally, however, so that they can be applied to other radiographic imaging modalities. In treating radiographic image quality, the report covers resolution, noise, and contrast. The treatment of transfer function analysis encompasses linearity and shift invariance, point spread function, line spread function, convolution, modulation transfer function (MTF) and Fourier spectrum. Various methods for the measurement of MTFs of screen-film systems and factors affecting MTFs, such as crossover exposure and x-ray beam quality are also treated. Appendices to the report provide mathematical derivations and a glossary.

Report No. 40

The Quality Factor in Radiation Protection

Executive Summary

This Report is the report of a joint task group of the ICRU and the International Commission on Radiological Protection to the two Commissions. It represents the culmination of an effort that the Commissions initiated when radiobiological findings indicated that protection recommendations for some high-LET radiations might not offer the same margin of safety as those for low-LET radiations. Sections of the report cover conceptual approaches to radiation protection C the limitation approach and the assessment approach; specification of radiation quality C in terms of linear energy transfer and lineal energy; and relative biological effectiveness (RBE) C autonomous and non-autonomous responses of cells and experimental findings. Brief appendices treat quantitative relations in radiation protection systems, the relationship between distributions in linear energy transfer and lineal energy, and theoretical considerations on RBE. Another appendix includes a comprehensive evaluation of the experimental data on RBE of high- vs. low-LET radiation.

Report No. 39

Determination of Dose Equivalents Resulting from External Radiation Sources

Executive Summary

ICRU Report No. 39 is the first of what will be a series of ICRU documents treating methods for determining the dose equivalents resulting from exposure to sources external to the body. The Report states definitions of quantities to be employed in the monitoring of ionizing radiation that provide a basis for effective radiation protection.

This Report discusses the dosimetric implications of recommendations of the International Commission on Radiological Protection, defines the dose equivalents pertinent for monitoring irradiation of the trunk of the body, and sets out desirable characteristics and current capabilities of instruments for measuring the defined dose equivalents. The information is intended to make it possible to specify, in numerical terms, the degree of irradiation that occurs when individuals are exposed to external sources of ionizing radiation.