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Book Review

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NCRP REPORT NO. 144—RADIATION PROTECTION FOR PARTICLE ACCELERATOR FACILITIES

National Council on Radiation Protection and Measurements

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This report, prepared for the NCRP by experts in the field of radiation protection, provides practical design and operational guidelines for radiation protection at particle accelerator facilities, with energies from ~5 MeV up to the highest energies available, as well as low-energy neutron generators. Accelerators are being increasingly used in medicine, research and industry. Many new installations are currently being built, especially synchrotron radiation machines, and new applications are being developed, such as radioactive waste transmutation. Thus, there is a continuing need to bring up to date the competence of professionals working in radiation protection around accelerators and to instruct new trainees. The report reflects the regulatory and technical changes that have occurred in the past three decades and supersedes NCRP Report No. 51, Radiation Protection Design Guidelines for 0.1–100 MeV Particle Accelerator Facilities, published in 1977.

The report comprises seven well-structured sections. The first section is a general introduction of the scope of the publication and includes information on national and international radiation protection standards and regulatory agencies.

Section 2 briefly reviews the history of accelerator development, describes the individual components of accelerator systems and finally provides general guidance for the siting and layout of accelerator facilities.

Section 3 discusses the various sources of ionising radiations from particle accelerators. After a brief review of the basic concepts of atomic and nuclear physics, the different radiations produced by energetic electrons, protons and ions are separately described; e.g. bremsstrahlung, neutron and muon yields are discussed and presented in analytical and graphical form. In addition, a series of useful 'rules of thumb' is provided for the assessment of the bremsstrahlung yields. Particular attention is focused on neutron generation in keeping with one of the stated goals of this report, i.e. to provide an update on NCRP Report No. 79, Neutron Contamination from Medical Electron Accelerators.

Section 4 discusses the shielding of electron, proton and ion accelerators up to the gigaelectronvolt energy region. Special attention is devoted to the rapidly emerging field of synchrotron radiation facilities. Theoretical, numerical and experimental aspects of shield design are discussed, including information on the properties of shielding materials, the design of penetrations through shielding and the design of shield doors. Extensive practical guidance is provided, which will be particularly useful to smaller institutions and organisations without large radiological protection staff to carry out complex radiation transport computations for shielding purposes.

Section 5 discusses personal and environmental monitoring, as well as field surveys at particle accelerators. Having defined the quantities in terms of which these measurements are expressed, still based on the recommendations of ICRP Publication 26 from 1977, the active (real-time) and passive radiation detectors available for this purpose are reviewed. The document covers Geiger–Mueller counters, proportional counters, fission chambers and counter telescopes, as well as thermoluminescence dosemeters, nuclear emulsions, track-etch techniques, superheated drop (bubble) detectors and activation measurements. The special problems of measurements in pulsed radiation fields and in 'mixed' photon/neutron fields of particle accelerators are discussed. Particular attention is devoted to neutron dosimetry and spectrometry techniques, since neutrons are often the most significant component of the radiation environment at the highest accelerator energies.

Section 6 discusses in detail the environmental impact of the operation of particle accelerators, including descriptions of skyshine effects, and the production and migration of radionuclides and non-radioactive toxic gases. Examples of the calculation of appropriate overhead shielding to reduce photon and neutron skyshine are provided, as well as methods of evaluating estimates of the population collective dose equivalent from exposure to accelerator-produced radioactivity.

The seventh and final section briefly outlines the basic elements and requirements of an operational radiation safety program, drawing the attention of the reader to the aspects that are unique to particle accelerators. Among these are conflicts between the requirements for easy access and the need to limit radiation leakage through the shielding, differences between radionuclides produced at nuclear reactors and at accelerators (more positron emitters) and the need for radiation detection techniques able to monitor positron and low-energy beta emitter contamination.

The report has two appendices, the first tabulating importance functions for both neutrons and photons, and the second giving tabulations of kinematic data for electrons, muons, kaons, protons, deuterons and selected heavier particles up to ^{238}U. In keeping with the tradition of the NCRP reports, an ample list of references is provided, which is quite comprehensive up to the year 2000.

Overall, NCRP Report No. 144 amply fulfils its aim of providing design and operational guidelines for radiation protection at particle accelerator facilities. The report contains an extensive compilation of available data on radiation yields and shielding coefficients, and plenty of valuable practical advice. Although it is published in the USA, the report contains information of general validity and of certain interest to the international radiation protection community.

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