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1990 Recommendations of the International Commission on Radiologic Protection

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Abstract - The International Commission on Radiological Protection issued its la basic recommendations in 1977. The recommendations have been used widely throughout the world to limit exposure of both radiation workers and members of public to ionising radiations. Supplementary statements to the 1977 recommend were issued when necessary by the Commission, but developments in the last fi years have made it necessary to issue a completely new set of recommendation officially adopted in November 1990. In publishing these recommendations, the Commission has had three aims in mind: to take account of new biological inforr and of trends in the setting of safety standards; to improve the presentation of th recommendations; and to maintain as much stability in the recommendations as consistent with the new information. The recommendations are set out in the for main text supported by annexes. The main text contains all the recommendation together with sufficient explanatory material to make clear the underlying reason for policy makers. The supporting annexes contain more detailed scientific information on specific points for specialists.

Recommended reference format for citations

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1. INTRODUCTION

Chapter 1 deals with the history of the Commission and its recommendations. It sets out the aims and form of this report. It indicates why the Commission concerns itself only with the protection of man and only with ionising radiation. A list of the Publications of the Commission is given in Annex D.

1.1. The History of the Commission

(3) The International Commission on Radiological Protection, hereafter called the Commission, was established in 1928, with the name of the International X ray and Radium Protection Committee, following a decision by the Second International Congress of Radiology. In 1950 it was restructured and renamed. The Commission still retains a special relationship with the four-yearly Congress meetings and with the International Society of Radiology but, over the years, has greatly broadened its interests to take account of the increasing uses of ionising radiation and of practices that involve the generation of radiation and radioactive materials.

(4) The Commission works closely with its sister body, the International Commission on Radiation Units and Measurements, and has official relationships with the World Health Organisation and the International Atomic Energy Agency. It also has important relationships with the International Labour Organisation and other United Nations bodies, including the United Nations Scientific Committee on the Effects of Atomic Radiation and the United Nations Environment Programme, and with the Commission of the European Communities, the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development, the International Standards Organisation, the International Electrotechnical Commission, and the International Radiation Protection Association. It takes account of progress reported by major national organisations.

(5) The Commission issued its first report in 1928. The first report in the current series, subsequently numbered *Publication 1* (1959), contained the recommendations approved in September 1958. Subsequent general recommendations have appeared as *Publication 6* (1964), *Publication 9* (1966), and *Publication 26* (1977). *Publication 26* was amended and extended by a Statement in 1978 and further clarified and extended by Statements in later years (1980, 1983, 1984, 1985, and 1987). Reports on more specialised topics have appeared as intermediate and subsequent publication numbers (Annex D).

1.2. The Development of the Commission's Recommendations

(6) The method of working of the Commission has not changed greatly over the last few decades. Since there is little direct evidence of harm at levels of annual dose at or below the limits recommended by the Commission, a good deal of scientific judgement is required in predicting the probability of harm resulting from low doses. Most of the observed data have been obtained at higher doses and usually at high dose rates. The Commission's aim is to draw on a broad spectrum of expertise from outside sources as well as from its own Committees and Task Groups and thus to reach a reasonable consensus about the outcome of exposures to radiation. It has not thought it appropriate

to use either the most pessimistic or the most optimistic interpretation of the available data, but has aimed at using estimates that are not likely to underestimate the consequences of exposures. The estimation of these consequences and their implications necessarily involves social and economic judgements as well as scientific judgements in a wide range of disciplines. The Commission has aimed to make the basis of such judgements as clear as possible, and recognises that others may wish to reach their own conclusions on many of the issues.

(7) The Commission has found that its recommendations have been used both by regulatory authorities and by management bodies and their specialist advisers. Because of the wide range of situations to which the Commission's recommendations might be applied, the degree of detail has deliberately been restricted. However, the Commission has had historical links with medical radiology and its advice in this area has often been more detailed.

(8) The Commission's recommendations have helped to provide a consistent basis for national and regional regulatory standards. For its part, the Commission has been concerned to maintain stability in its recommendations. It believes that frequent changes would only cause confusion. The Commission reviews the newly published data annually against the background of the much larger accumulation of existing data. It is not likely that dramatic changes would be called for by these reviews, but if new data should show the existing recommendations to be in need of urgent change, the Commission would respond rapidly.

(9) Over the last few decades, there has been a significant change in emphasis in the presentation and application of the system of protection recommended by the Commission. Initially, and into the 1950s, there was a tendency to regard compliance with the limits on individual doses as being a measure of satisfactory achievement. The advice that all exposures should be kept as low as possible was noted, but not often applied consciously. Since then, much more emphasis has been put on the requirement to keep all exposures "as low as reasonably achievable, economic and social factors being taken into account". This emphasis has resulted in substantial decreases in individual doses and has greatly reduced the number of situations in which the dose limits play a major role in the overall system of protection. It has also changed the purpose of the dose limits recommended by the Commission. Initially, their main function was the avoidance of directly observable, non-malignant effects. Subsequently, they were also intended to limit the incidence of cancer and hereditary effects caused by radiation. Over the years, the limits have been expressed in a variety of ways, so that comparisons are not easy. In broad terms, however, the annual limit for occupational exposure of the whole body was reduced by a factor of about 3 between 1934 and 1950, and by a further factor of 3, to the equivalent of 50 mSv, by 1958.

1.3. The Aims of this Report

(10) The Commission intends this report to be of help to regulatory and advisory agencies at national, regional, and international levels, mainly by providing guidance on the fundamental principles on which appropriate radiological protection can be based. Because of the differing conditions that apply in various countries, the Commission does not intend to provide a regulatory text. Authorities will need to develop their own structures of legislation, regulation, authorisations, licences, codes of practice, and guidance material in line with their usual practices and policies. The Commission

believes that these regulatory structures should be designed to be broadly consistent with the guidance in this report. In addition, the Commission hopes that the report will be of help to management bodies with responsibilities for radiological protection in their own operations, to the professional staff whom they use as their advisers, and to individuals, such as radiologists, who have to make decisions about the use of ionising radiation.

(11) The Commission has therefore set out these recommendations in the form of a main text supported by more detailed annexes. The main text contains all the recommendations, together with sufficient explanatory material to make clear the underlying reasoning. It is intended to be used by those concerned with policy, who can turn to the supporting annexes if they need more detailed information on specific points. Specialists will need to study both the main text and the annexes.

(12) Chapters 2 and 3 deal with the quantities and units used in radiological protection and with the biological effects of radiation. Chapter 4 describes the conceptual framework of radiological protection and leads into Chapters 5 and 6 which deal with the Commission's main recommendations. Chapter 7 discusses the practical implementation of the recommendations. Finally, there is a summary of the recommendations.

1.4. The Scope of the Commission's Recommendations

(13) Ionisation is the process by which atoms lose, or sometimes gain electrons and thus become electrically charged, being then known as ions. Ionising radiation is the term used to describe the transfer of energy through space in the form of either electromagnetic waves or subatomic particles that are capable of causing ionisation in matter. When ionising radiation passes through matter, energy is imparted to the matter as ions are formed.

(14) The recommendations of the Commission, as in previous reports, are confined to protection against ionising radiation. The Commission recognises the importance of adequate control over sources of non-ionising radiation, but continues to consider that this is a subject outside its own field of competence. It also recognises that this concentration on a single one of the many dangers facing mankind may cause an unwanted element of anxiety. The Commission therefore wishes to emphasise its view that ionising radiation needs to be treated with care rather than fear and that its risks should be kept in perspective with other risks. The procedures available to control exposures to ionising radiation are sufficient, if used properly, to ensure that it remains a minor component of the spectrum of risks to which we are all exposed.

(15) Ionising radiation and radioactive materials have always been features of our environment, but, owing to their lack of impact on our senses, we became aware of them only at the end of the 19th century. Since that time, we have found many important uses for them and have developed new technological processes which create them, either deliberately or as unwanted by-products. The primary aim of radiological protection is to provide an appropriate standard of protection for man without unduly limiting the beneficial practices giving rise to radiation exposure. This aim cannot be achieved on the basis of scientific concepts alone. All those concerned with radiological protection have to make value judgements about the relative importance of different kinds of risk and about the balancing of risks and benefits. In this, they are no different from those working in other fields concerned with the control of hazards.

(16) The Commission believes that the standard of environmental control needed to protect man to the degree currently thought desirable will ensure that other species are

not put at risk. Occasionally, individual members of non-human species might be harmed, but not to the extent of endangering whole species or creating imbalance between species. At the present time, the Commission concerns itself with mankind's environment only with regard to the transfer of radionuclides through the environment, since this directly affects the radiological protection of man.

2. QUANTITIES USED IN RADIOLOGICAL PROTECTION

Chapter 2 explains in simple terms the principal quantities used in radiological protection. The formal definitions and more detailed information are given in Annex A.

2.1. Introduction

(17) Historically, the quantities used to measure the "amount" of ionising radiation (subsequently called "radiation" in this report) have been based on the gross number of ionising events in a defined situation or on the gross amount of energy deposited, usually in a defined mass of material. These approaches omit consideration of the discontinuous nature of the process of ionisation, but are justified empirically by the observation that the gross quantities (with adjustments for different types of radiation) correlate fairly well with the resulting biological effects.

(18) Future developments may well show that it would be better to use other quantities based on the statistical distribution of events in a small volume of material corresponding to the dimensions of biological entities such as the nucleus of the cell or its molecular DNA. Meanwhile, however, the Commission continues to recommend the use of macroscopic quantities. These, among others, are described in Annex A and are known as dosimetric quantities. They have been defined in formal terms by the International Commission on Radiation Units and Measurements (ICRU).

(19) Before discussing dosimetric quantities, it is necessary to anticipate some of the information on the biological effects of radiation described in Chapter 3. The process of ionisation necessarily changes atoms and molecules, at least transiently, and may thus sometimes damage cells. If cellular damage does occur, and is not adequately repaired, it may prevent the cell from surviving or reproducing, or it may result in a viable but modified cell. The two outcomes have profoundly different implications for the organism as a whole.

(20) Most organs and tissues of the body are unaffected by the loss of even substantial numbers of cells, but if the number lost is large enough, there will be observable harm reflecting a loss of tissue function. The probability of causing such harm will be zero at small doses, but above some level of dose (the threshold) will increase steeply to unity (100%). Above the threshold, the severity of the harm will also increase with dose. For reasons explained in Section 3.4.1, this type of effect, previously called "non-stochastic", is now called "deterministic" by the Commission.

(21) The outcome is very different if the irradiated cell is modified rather than killed. Despite the existence of highly effective defence mechanisms, the clone of cells resulting from the reproduction of a modified but viable somatic cell may result, after a prolonged and variable delay called the latency period, in the manifestation of a malignant condition, a cancer. The probability of a cancer resulting from radiation usually increases with increments of dose, probably with no threshold, and in a way that is roughly proportional to dose, at least for doses well below the thresholds for deterministic effects. The