DEVELOPMENT AND TRENDS IN RADIOLOGICAL PROTECTION AND THE NEA PROGRAMME IN THIS FIELD

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INTRODUCTION

The Nuclear Energy Agency (NEA) was initially created as a European organisation (ENEA) in 1957, but it assumed its present broader configuration in 1972 with the entrance of Japan among participating countries, successively followed by Australia, Canada, and the United States. A major task of NEA is to encourage harmonization of governments' regulatory policies and practices and to promote the exchange of information and the co-ordination of research and development in the field of radiological health and safety.

The work of the Agency is carried out under the authority of the OECD Council by the Steering Committee for Nuclear Energy which is assisted in its work by a number of specialised committees. In particular, the Committee on Radiation Protection and Public Health, which had originally been set up in 1958 as the Health and Safety Sub-Committee, is responsible for the Agency's activities concerned with radiological protection and related environmental problems. Its activities include the review and discussion of national radiation protection policies and practices, the review of progress of radiation protection philosophy and the interpretation of the ICRP Recommendations, the study of the means of their conversion into practical applications, including the establishment of radiological protection standards as well as the preparation of technical studies and state-of-the-art reviews on specific problems.

THE EARLY DEVELOPMENTS

Since the beginning, radiological protection became a major part of the Agency's programme. The areas of concern for the national and international radiation protection communities changed significantly during the last 25 years, and the Agency programme evolved with them. During the 1950s and the early '60s, the attention of public authorities and radiation protection specialists was primarily focused on two major questions.

One was the need to elaborate radiological protection regulations. Many countries, at that time, had not yet worked out these measures in detail, and still lacked the necessary experience to implement them. Moreover, it was soon realised that these regulations should have been as uniform as possible throughout countries in order to avoid international trade and public opinion repercussions resulting from inadequacy or excessive severity of individual national regulations. This need for an international co-ordination was soon appreciated by the

Steering Committee, and the first task of the newly-created Health and Safety Sub-Committee was the preparation of basic norms for protection against radiation. These norms were adopted in 1959 for use in Member countries as one of the bases for their forthcoming legislations. One specific concern in preparing these norms, in line with the Agency's vocation, was to transfer the ICRP policy and conceptual language into more practical terms, more easily applicable to a regulatory context. The Agency did not limit its effort to the preparation of basic norms, but it continued to keep under constant review the developments and trends of radiation protection policy and the ICRP recommendations. In this context, the basic norms were subjected to revision in 1963 and 1968. A major revision is also currently under way in order to take into account the new principles set down in ICRP Publication 26. This revision presents a significant difference from the previous ones; the latter were in fact carried out independently by NEA, though in co-ordination with other international organisations. In the last few years, however, it was realised that it was in the interest of Member countries to have a single series of international recommendations on radiation protection norms. Therefore, arrangements were made in 1977 with IAEA, WHO and ILO to prepare a joint revision of the relevant norms and to publish a unified set of standards applicable by all international organisations. The publication of the joint revised basic norms is expected by 1981.

The second major concern in the period of the 1950s and early 60s was the public health risks associated with the radioactive fall-out from nuclear explosions, and the methods and techniques for the measurement of low levels of activity in environmental matrices. Also in this field, the Agency played an active role. This was the setting up, in 1959, of a system for the centralised collection, comparison and dissemination of information and data resulting from the network of environmental radioactivity measurement stations located in Europe. This mechanism for an oriented exchange of information was operated for about 10 years; then, with the dramatic decrease in environmental radioactivity levels in the years after 1962, interest in an international exchange of information declined and the system was discontinued. Also, the Agency deployed a limited effort towards standardisation of sampling and measurement methods used in the different countries.

The concern of national authorities at the increasing levels of environmental contamination due to fall-out, and the growing awareness of the risk of nuclear accidents possibly involving bordering countries, induced NEA to set up, in 1961, an international system of supervision and emergency warning in the case of an increase in environmental radioactivity in one Member country. The technical features of this system, the scope of which

was based only on the results from airborne radioactivity measuring stations, were of course not such as to generate a really timely and effective warning mechanism. However, those features were in line with the technical means and knowledge available at that time and, in any event, the NEA system had the undeniable merit of supplying a pre-arranged framework for quick contacts and consultations between national authorities in case of any problems concerning radiological protection of the public. It should also be appreciated that this system, with its obvious limitations, was probably the first international attempt to set up forms of co-operation between countries in the field of nuclear emergencies. The system was operated for several years, and successively, although it was never officially abrogated, it was practically abandoned in the last few years. In any event, the seed of international co-operation had been sown, and since then better and technically more adequate emergency warning and co-operation systems have been set up between bordering countries.

THE MATURITY OF THE AGENCY'S PROGRAMME

The 1960s saw the suspension of significant nuclear tests in the atmosphere, and the parallel impetuous development of nuclear energy and its various applications. In this changing scenario, other issues assumed a growing emphasis. These were the problems and techniques involved in the protection of workers in nuclear establishments, and the methods and instruments for the health physics surveillance and dosimetry. In these fields NEA did not play a leading role, apart from organising a number of seminars and symposia on health physics and dosimetry matters. In the same period, however, NEA showed a particular sensitivity and promptness in tackling some other problem areas which were at that time only beginning to concern public health authorities.

The ICRP Publication 7, in 1965, introduced a significant quality step into the criteria for the environmental monitoring around nuclear facilities. Concepts such as the critical groups of population and critical parameters of the environment were the basis for a more rational and cost-effective approach to monitoring, and paved the way for the development of the analytical models which are now an essential tool for the assessment of the environmental impact of any nuclear facility or waste management operation. Since 1961, the NEA Health and Safety Sub-Committee realised the importance of this subject, and focused its attention on the study of the environmental behaviour of radioactive wastes in the marine environment, and the associated radiological risks. A number of studies were therefore carried out between 1962 and 1964 on the oceanographic and radiological aspects of the presence of radioactive materials and the discharge of radioactive wastes into the North Sea. These preparatory studies culminated with the preparation

of a joint theoretical study of the radiological capacity of the North Sea for the discharge of radioactive wastes. This was probably one of the first examples of a radiological risk assessment applied to a large ecosystem and, we suppose, it was the first to result from a joint international effort. This specialisation of NEA expertise on the problems associated with waste disposal into the sea constituted the basis for the increasing involvement of the Agency in the study and, successively, the implementation of operations involving waste disposal into the ocean under international surveillance. In this field, the Agency had, and still conserves in the framework of the Multilateral Consultation and Surveillance Mechanism for Sea Dumping of Radioactive Waste established in 1977, the role of organising an international co-operation, including radiological risk assessments and radiological protection inspection during the disposal operations, on a practice followed by several countries and which might otherwise be carried out without proper guarantees and information to all countries.

The other problem area in which NEA showed a prompt adaptation to the forthcoming requirements of Member countries was the spreading application of small quantities of radioactive materials in consumer goods of any sort. At that time the concern was focused on the individual risk from radiation exposure and the protection of individuals. Only a few, far-sighted experts were anticipating the far-reaching importance that the collective radiation detriment would take on in the following years and the resulting potential public health problems to be raised by the exposure of large groups of people to small levels of radiation. It is therefore to be ascribed to the merit of NEA the vigorous programme, carried out from 1962 to 1978, of studies and guidelines on the radiation protection problems raised by public exposure to consumer goods containing radioactivity and by natural, but artificially enhanced, radiation exposures. The NEA action in this field was in line with its institutional goal of transferring the philosophical language of the ICRP recommendations and the administrative/regulatory language of the basic radiation protection norms into terms more suitable for direct application to specific situations.

This activity started in 1962 with the preparation of radiation protection standards for radioluminous timepieces (published in 1967) and continued very actively with the publication (between 1970 and 1977) of standards or guidelines concerning the design, construction and use of radioisotopic power generators, gaseous tritium light devices, particle accelerators, cardiac pacemakers, smoke detectors. It is important to note that several of the above guides and standards were developed in collaboration with the other international organisations and some of them were also adopted by IAEA as their own standards.

A particularly interesting case of a guide in this

area was that entitled "Basic approach for safety analysis and control of products containing radionuclides and available to the general public" published by NEA in 1970. While the other guides were intended for use not only by regulatory authorities, but also by designers and utilisers, the latter was exclusively addressed to regulatory authorities. It contains the general principles of the analysis that licensing authorities should carry out before granting authorisations, as well as the technical bases for this analysis and the control procedures to be set up.

At this point, it is worth noting that, besides the basic radiation protection norms, the field of consumer goods is the only one where NEA embarked on an activity of international standards and guides. In the other fields, also in harmony with a general co-operation and co-ordination agreement signed with the IAEA in September 1960, the Agency focused its activity on the study and catalysation of co-operative efforts in advanced areas still presenting open problems.

The activity of NEA in the area of consumer goods and natural radiation was not limited to the publication of standards and guides, but also a number of studies were carried out. It is sufficient to mention the studies on radiation protection problems of lightning conductors, use of depleted uranium as ballast in aircraft, radioactivity of building materials, airborne natural radioactivity, etc. Not all of these studies were widely disseminated through formal publication. A few of them, in fact, remained, for various reasons, at the stage of reports for internal use by the national authorities. But even in this limited distribution, they represented a useful reference contribution to the development of knowledge and radiation protection criteria in Member countries.

THE PRESENT EVOLUTION AND FUTURE TRENDS

In the last ten years nuclear energy, which had previously shown promising development, began to face growing opposition as well as increasing economic and political difficulties. One of the concerns at the basis of this crisis was a deep and sometimes exasperated attention to the environmental impact of nuclear energy. This called for great efforts to be focused on the treatment and retention of radioactive effluents, as well as on the methods for assessment of the environmental behaviour and radiological impact of these effluents and for their monitoring. But the attention of the experts and the public opinion were progressively concentrating on the question of the long-term management of radioactive wastes. This immediately began to raise the problems of the assessment and criteria for acceptance of the associated long-term radiological risks. In this context, a particular international resonance was given to the publication by NEA, in 1977, of a state-of-the-art report,

known as the Polvani report, on the concepts and strategies for the management of radioactive wastes.

During the 1970s, NEA rapidly became sensitive to these new requirements and its programme was progressively adapted by the Committee on Radiation Protection and Public Health to cope with the new challenges. In particular, the Committee reoriented the emphasis of the programme towards the problems of radiation protection and environmental impact of nuclear fuel cycle facilities, with special attention to the front-end (uranium mining and milling) and the back-end (waste management) of the fuel cycle. Its growing involvement in the problems associated with the nuclear fuel cycle obliged the Agency to concentrate its limited resources in those areas where a priority effort appeared warranted. Therefore, while increasing efforts were devoted to sensitive issues in the nuclear fuel cycle, the activities in areas not directly connected with the fuel cycle, such as the consumer goods and other low-level sources of radiation detriment, were progressively reduced to minimal levels.

The turning point of this evolving policy was in 1976. In that year, for the first time, the major part of the Agency's programme was devoted to radiation protection in the nuclear fuel cycle. Here again, the Agency fulfilled its vocation for tackling new problems in the moment of their formation and catalysing international interest and efforts towards their solution. In the last few years, in fact, the areas which called for attention were the transfer into practical terms of the new ICRP recommendations of Publication 26, the protection of the public and future generations against the long-term sources of radiation such as the uranium mill tailings and high level transuranic wastes, and the protection of workers in selected occupations with relatively high risks, such as uranium mining and maintenance work in nuclear power plants. Most of the new lines of activity started in 1976 were in fact focusing on selected issues in the abovementioned areas. In order to put into a proper perspective the radiological impact of the different stages of the nuclear fuel cycle and the problem areas requiring a selective effort, the first action of NEA was to sponsor a study on the relative radiological significance of all potential sources of human exposure to radiations. The report on this study, prepared by Sir Edward Pochin, was published in 1976.

In the field of the long-term impact of the nuclear fuel cycle, the criterion adopted was to select a few radionuclides of particular significance as potential long-term sources of human irradiation, and to study in detail their behaviour and their potential risk for present and future generations. A first study was focused on plutonium and other transuranics: this was of a scientific nature and its objective was to bring together the salient facts about the biological and environmental behaviour of these nuclides in order to assist in the

appreciation of their potential risk. The result of this study is a comprehensive state-of-the-art report, publication of which is planned by mid-1980.

Another case of a specific study in this general area was an analysis of the radiological significance of four long-lived radionuclides arising, as airborne effluents, from the operations of the nuclear fuel cycle, namely ^{3}H, ^{14}C, ^{85}Kr and ^{129}I. The particular interest of this study lies in the fact that it is one of the first examples, perhaps the first from an international group of experts, of an attempt to demonstrate a practical application of the ICRP optimisation principle. The study, in fact, assesses the radiation detriment and costs associated with different retention technologies and combines them into a differential cost-benefit analysis, concluding with recommendations as to the policies to be followed for an optimised management of the above nuclides. In spite of a certain delay due to its industrial policy implications, it is hoped that the final report will be published during 1980.

Another issue of concern, both from the occupational exposure and environmental protection viewpoints, was the expansion in several countries of uranium mining and milling activities. The involvement of NEA in this field began in 1976 with the organisation of exchanges of information on personal dosimetry and area monitoring in uranium mines. The international debate progressed during the last three years with other meetings and seminars, within the framework of NEA, and permitted the clarification of the nature of the problems and identification of key subjects requiring a priority attention or effort. On this basis, the Agency was able to establish, in 1979, a consolidated programme on the long-term radiation protection and waste management aspects of the uranium mill tailings. These were, in fact, identified as a form of radioactive waste of low specific activity but having significant long-term implications due to their enormous quantities and very long half-life of the radionuclides involved. This three-year programme is presently starting and includes items such as the formulation of radiological protection principles and criteria for application to the long-term management of tailings, based on the ICRP system of dose limitation, as well as the study of environmental models for the assessment of the impact of the release of contaminants from the tailings.

Another area where the abovementioned international debate led to the establishment of a stimulating programme was the parallel subject of radon, and its daughters dosimetry and monitoring for workers and for environmental surveillance in connection with uranium mining and with mill tailings management. A sizeable effort is presently going to be devoted to studies on the analytical models for radon dosimetry, the influence of factors and parameters affecting the dose to lung from

radon and its daughters, the principles and methods for measurement and monitoring of radon and daughters.

During the last few years, increasing improvements have been made in the safety of nuclear plants against accidents and the treatment and containment of radioactive wastes. However, these achievements were partly obtained at the cost of increasing radiation exposure to workers. Therefore, the concern of experts and authorities is now focusing on the trends of occupational exposure in nuclear plants, and no doubt this will continue to be a major issue during the next few years until adequate solutions are found and implemented. The achievement of this goal should be pursued applying the ICRP principle of optimisation. For this purpose, an adequate data base should be assembled, from which the criteria for optimising occupational exposure in the design and operation might be derived. In order to contribute to the above data base, NEA, in co-operation with IAEA, launched in 1978 a study on this subject based on an international enquiry aimed at collecting information on the levels and trends of occupational exposure in nuclear facilities and helping to identify critical groups of workers, critical operations and critical equipment in the plants, as a basis for the study of design and operational procedures improvements. This enquiry supplied a large amount of valuable data and the resulting study is very well advanced. Publication is envisaged for 1980.

Only the most important components of the current NEA programme have been briefly described here, but several other activities are also carried out or planned. These include studies and other forms of international co-operation in fields such as the development of practical examples of application of the ICRP optimisation principle, the preparation of state-of-the-art reports on the radiological and environmental protection aspects of the nuclear fuel cycle facilities, the development of radiation protection criteria for the geologic disposal of high level radioactive wastes, the study of radiation protection problems of the decommissioning of nuclear plants, the international review of nuclear emergency planning criteria and reference levels. This last item, which was already the object of a specialist meeting organised by NEA in 1976, has seen a renewed interest since the Three Mile Island accident in 1979 and is presently being considered by the Agency with a view to launching a programme of international co-operation in this area.

We have tried to give an overview of the evolution of the radiation protection problems and concerns in the last 25 years, in connection with the effort of NEA to assist Member countries in finding a timely and efficient solution to their national problems through a harmonised gathering of efforts and contributions at the international level. This effort has frequently been successful in spite of the obvious difficulties of debating certain sensitive matters at the international level, and we are confident that NEA will continue to be a useful contributor to international co-operation for the constant improvement of radiological protection.