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AN OUTLOOK TO RADIATION PROTECTION DEVELOPMENT

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INTRODUCTION

Radiation protection is a term applied to concepts, requirements, technologies and operations related to protection of people against health effects of ionizing radiation. A scope of radiation protection is shown in Figure 1 [1].

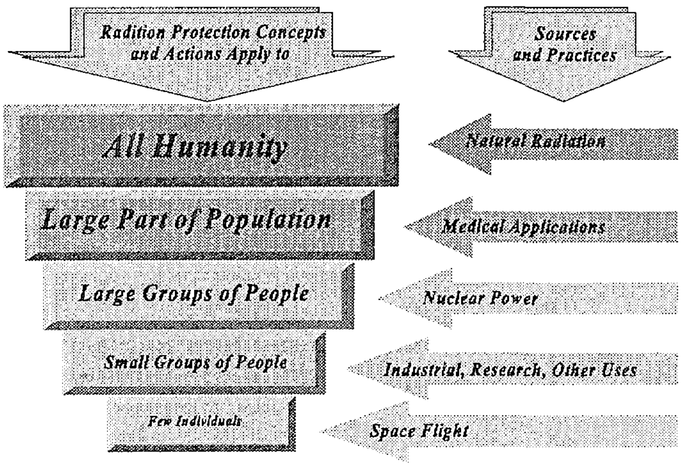

Fig. 1: Scope of Radiation Protection [1].

Radiation protection and safety have developed over many decades as the effects of ionizing radiation have been better and better understood. Some events in the last decade had essential impact on radiation protection policy/philosophy and related safety standards. Among them are available data of some long term radio-epidemiological studies of populations exposed to radiation. Investigations of the survivors of the atomic bombing of Hiroshima and Nagasaki illustrated that exposure to radiation has also a potential for the delayed induction of malignancies. They also showed that irradiation of pregnant women may result with certain mental damage in foetus. Several big radiation accidents which appeared in the last decade also had an impact on developments in radiation protection philosophy and practices. A well known Chernobyl accident showed that limited knowledge was available at the time of the accident on transfer of radionuclides in a specific environment, radioecological effects and pathways of highly radioactive atmospheric precipitation generated during the accident on various components of the environment. New scientific data indicated also that in some parts of human environment there are measurable effects of chronic exposure resulting from natural radiation. UNSCEAR is periodically publishing the most valuable set of data as compilation, and disseminates information on the health effects of radiation and on levels of radiation exposure due to different sources. These data are also the best guidelines for the necessary improvements and updating of radiation protection practices and philosophies. The latest ICRP-60 publication [2] and recently issued International Basic Safety Standards for Protection Against Ionizing

Radiation and for the Safety of Radiation Sources [3] are reflecting many of the above mentioned findings.

On the other hand the use of radiation sources is increasing day by day, and many new facilities applying radiation in radiotherapy, radiodiagnostic, nuclear medicine, industry, agriculture and hydrology were established. This, of course, increases the number of people involved in radiation practices and requires additional attention to regulators. To illustrate the diversity and magnitude of some applications of radiation sources, an estimated overview is presented in Table 1. The authors would like to draw attention to figures indicating estimated number of applications to patients. Studying these estimated figures and taking into account collective dose received by patients worldwide, one can easily argue why additional efforts are needed to improve radiation protection of this significant group of population.

RADIATION PROTECTION AS A MODEL HOW TO DEAL WITH HAZARDS

Mankind is exposed to various hazards and radiation being just one of them. The effects of radiation were always of big concern, not only for scientists but also for the general public. Very strong criticism and continuous impact of the public on some facilities based on ionizing radiation contributed - among other technical and scientific anxieties - to a systematic approach in establishing safety standards and practices based on these standards. Good and reliable measures and practices for radiation protection were developed based on a large number of extensive systematic investigations. A reasonably good infrastructure for radiation protection was established worldwide. Based on this good and effective practice for radiation protection, similar activities have started for other types of hazards (toxic chemicals, heat, noise, etc.). From this fact one may conclude that the approach applied to radiation hazards was evaluated positively and that there is a strong tendency to adapt it to other hazards. On the other hand this trend shows positive impact of the general public. Radiation hazards present a small part of all hazards to which the mankind is exposed these days. Radiation protection having a leading role in creating a strategy how to minimize hazards and regulate practices where various hazards are involved, also demonstrated that radiation hazards present just a small fraction of all hazards to which we are exposed. Therefore, a future trend in radiation protection could be expected to include comparison of these hazards with others and evaluation of all of them jointly. This also implies that one may expect further efforts in systematic improvement of our knowledge on the fate of radionuclides in the environment, effects of radiation to living organisms and future generations as well as the synergetic effects of various hazards. By applying the approach, tested in radiation protection to other hazards, a recognition was demonstrated showing that such an approach is acceptable and a reliable method in assurance of handling and use of hazardous materials. Therefore we may foresee that further investigations and improvements will follow keeping the leading role of radiation protection methodology among hazardous materials.

RADIO-EPIDEMIOLOGICAL STUDIES

The area of radiation protection which requires more investigations is radio-epidemiology. The Chernobyl accident showed that our knowledge on chronic exposures resulting from contamination from accidents, past practices or inadequate discharges/deposition of radioactive materials is rather scarce. Therefore we may foresee radio-epidemiological investigations not only in the Chernobyl affected areas, but also in other largely contaminated or potentially contaminated areas such as Kyrgyzstan area, Northsea, Sea of Japan, areas around underground nuclear weapon testing sites, abandoned military weapon sites, some inadequate radioactive waste depositary sites, etc. To these examples should be added accidentally contaminated areas (e.g. Goiania) and those where exists chronic exposure resulting form natural radiation. As indicated by many professionals, the results of the many radio-epidemiological studies conducted throughout the world on groups of workers and members of the public are affected by significant uncertainties and practical difficulties such as accounting for confounding factors and need for sufficient follow-up. It is therefore our opinion that radio-epidemiological studies will be one of the key activities in radiation protection in the forthcoming period. They are also expected to shad more light on some other aspects of radiation protection where increased knowledge and data are needed, such as the non-threshold and linear dose-effect relationship.

INTEGRATED APPROACH TO RADIOLOGICAL RISK

The new International Basic Safety Standards for Radiation Protection [3] based on ICRP-60 recommendations [2] indicated the need for an integrated approach to radiological risk. This means that not only protection against exposures, which has likely been the case in the past, will be applied but also potential exposures. Consequently this means that future developments in radiation protection will include tasks regarding developing practical methodologies for the assessment and regulation of situations where there is a potential for exposure. A potential exposure is understood as an exposure that is not expected to be delivered with certainty, but which can result form an accident at a source or due to an event or sequence of events of a probable nature, including equipment failures and operating errors.

However, there could be some difficulties in application of this radiological risk management concept and investigations will indicate how it can be applied. Probabilitic safety assessment (PSA) methodology which is applied in nuclear power industry can possibly be employed to identify, quantify and manage the risk.

Number	*Machines and Sources*
4.50e+02	Power Reactors
3.50e+02	Research Reactors
3.00e+02	Neutron Generators
1.70e+02	Large Gamma Irradiators
4.00e+03	Electron Beam Accelerators
7.00e+02	Accelerators in Industrial Applications
5.00e+04	Industrial Radiotherapy Devices
1.20e+04	Brachytherapy Sources
3.00e+03	Theletherapy Devices
1.00e+06	X-Ray Machines
Number	*Applications*
1.20e+09	X-Ray Controls Annually
3.50e+08	Dental X-Ray Controls Annually
3.00e+07	Nuclear Medicine Applications Ann.
6.00e+06	Radiotherapy Treatments Annully

Table 1: Diversity and Magnitute (approximately) of Nuclear Applications Worldwide.

MEDICAL EXPOSURES

As it can be seen from Table 1 there is a wide use of ionizing radiation in various medical practices. Millions of patients undergo annually X-Ray diagnostic investigations and/or radiotherapy treatment. Therefore the new basic safety standards pay due attention to optimize these applications avoiding unnecessary irradiations. Therefore the application of these new standards require improvement of operational radiation protection. Much more efforts will be needed to assure that in all radio-therapy units, calculation of individual doses for patients undergoing radiotherapy treatment will be done, that (when necessary) shielding of other parts of the patient body will be managed, and that an adequate dosimetry regarding the (distribution of) absorbed dose is assured. According to the data available at present in a large number of countries, these requirement are not yet included into the regular radiotherapy procedure. Being aware of this, one may assume, that a lot of effort will be needed to provide an adequate radiation protection training to both medical and paramedical staff involved in radiotherapy practices.

MODELLING OF ENVIRONMENTAL TRANSPORT OF RADIONUCLIDES

The Chernobyl accident showed how important is to elaborate environmental models for transport of radionuclides in a local and/or regional environment. In the absence of such models environmental emergency actions were delayed and in most cases were not adequate. On the other hand the Chernobyl accident provided in its later stage an opportunity to test and validate some of models prepared elsewhere for other local environments. Generally, it was demonstrated that there are limitations of knowledge, especially regarding the impact of radiological processes and local environmental characteristics on the fate of radiocontaminants as well as on the long-term contamination of the local environment.

It seems that in the years to come modelling will be focused to the following two aspects: (i) validitation of models elaborated to cover the most general needs of day-to-day radiation protection of the public, and

(ii) elaboration and validation of new models taking care of possible nuclear and radiocontamination accidents including the residues of military nuclear activities. In any case these activities will require research to collect more data from local environment.

OTHERS

These are some most evidently radiation protection required activities in the future. There are many more of them, which will also shape the trend of radiation protection practices. Among them are radiation protection aspects of waste storage and deposition, decommissioning and dismantling of nuclear reactors, nuclear fuel cycle and nuclear military installations.

Research activities on a number of tasks will continue. The risk of radiation effects on the developing brain of the embryo/foetus is not yet completely known and some questions regarding mental retardation require additional investigation. Also more data are needed regarding the effects of radiation in some local environments. It is expected that new types of instruments will be made available for the detection/measurement of radiation, primarily those which may allow in-situ prompt measurements of various pollutants. Etc.

CONCLUSION

In conclusion we may stress that there is an evidence that radiation protection is entering new tasks and identifying new priorities. However, even so, we have to be aware that there is still a large number of the developing states having not satisfactory radiation protection infrastructure, which is a precondition for good radiation protection management. Therefore, for many countries, radiation protection activities will continue to be focused on strengthening vital components of infrastructure such as regulation, licensing, inspection and man-power development.

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