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Impact of New Radiation Safety Standards on Licensing Requirements of Nuclear Power Plant

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ABSTRACT. As the outcomes of the newly introduced safety philosophies, new and more strict safety design requirements for nuclear installations are expected to be introduced. New in-depth defence measures should be incorporated into the design and operation procedure for a nuclear installation, to compensate for potential failures in protection or safety measures. The new requirements will also apply to licensing of NPP's operation as well as to licensing of nuclear sites, especially for radioactive waste disposal sites.

This paper intends to give an overview of possible impacts of new internationally agreed basic safety standards with respect to NPP and related technologies. Recently issued new basic safety standards for radiation protection are introducing some new safety principles which may have essential impact on future licensing requirements regarding nuclear power plants and radioactive waste installations. These new standards recognise exposures under nonnal conditions ("practices") and intervention conditions. The term interventions describes the human activities that seek to reduce the existing radiation exposure or existing likelihood of incurring exposure which is not part of a controlled practice. The other new development in safety standards is the introduction of so called potential exposure based on the experience gained from a number of radiation accidents. This exposure is not expected to be delivered with certainty but it may result from an accident at a source or owing to an event or sequence of events of a probabilistic nature, including equipment failures and operating errors.

1. Introduction

Internationally accepted basic safety standards for protection against ionising radiation are global frames for any use of radiation sources for peaceful purposes. These basic safety standards are formulated by the International Commission on Radiological Protection (ICRP) composed of high level experts and/or scientists in radiation protection and related areas. This body, taking into account the newest scientific data regarding the impact of ionising radiation on man and his environment, has published in 1991 new set of recommendations. Principal base for these new recommendations are elaborated from the recently finished radioepidemiological studies of the somatic and genetic effects of several cases of large populations being exposed to ionising radiation. The most important among these cases were 40-year surveys of the survivors and their descendants of the Hiroshima and Nagasaki nuclear bombing in 1945. Based on these data, as well as on many other, thoroughly investigated cases, a set of new and more restrictive recommendations was prepared. In other words the new recommendations take account of the new biological information and trends.

Based on these ICRP recommendations 1,2 International Basic Safety Standards for Protection against Ionising Radiation and for the Safety of Radiation Sources 3, were prepared by a group of the international specialised agencies, namely FAO, IAEA, ILO, OECD/NEA, PAHO and WHO. These Basic Safety Standards, among some other tasks, highlighted the importance of national regulatory authorities in full and proper implementation of internationally agreed standards.

2. New Approach of ICRP-60 and ICRP-64

So far radiation safety philosophy was based on so called system of dose limitation. With new scientific information on biological effects of radiation, including those on the risk of radiation-induced cancers, the system of dose limitation became inadequate, and was therefore replaced by "system of radiological protection". The conceptual framework of radiological protection introduces the idea of source-related and individual-related assessments and it distinguishes between a "practice" which causes exposure, and "intervention" which decreases exposure. Furthermore it outlines a basic system of protection for occupational, medical and public exposures.

The third main issue introduced into new basic safety standards is potential exposure. It is not expected to be delivered with certainty but it may result from an accident at a source/installation or owing to an event or sequence of events of a probabilistic nature, including equipment failures and operating errors. Examples when this is important are probability of exposure in radiation accidents and disposal of radiation materials.

New basic safety standards cover all people who may be exposed to radiation, including those in future generations who could be affected by present practices and interventions. It is therefore evident that some additional and new requirements will be needed in the process of construction, use, service and/or deposition of radiation sources.

3. New Regulatory Requirements

The new basic safety standards will in any case have some impact on nuclear regulatory activities, primarily on design requirements and licensing procedures. Even these basic safety standards do not entail any obligation for States to bring their legislation into conformity with them, nor are they intended to replace the provisions of national laws and regulations, or standards in force, they have so far been accepted by more than 100 States. It will take some time to introduce these new safety standards into national legislation and practices. Being aware that most of nuclear installations have life-time of 30 or more years it become evident that in planning process for any new installation these new standards should be taken into account. Evenmore, one should consider how this will reflect on the presently operating nuclear installations as well as on the need for their re-licensing. Manufacturers of nuclear installations and related components will also be faced with the required safety improvements.

With regard to the newly recommended dose limits a large number of operating licences need to be reviewed and harmonised with new lower values. Care should be taken keeping in mind that new ICRP recommendations give 20 mSv per year averaged over defined periods of 5 years for occupational exposure, and 1 mSv per year for public exposure. It is assumed that the application of these new dose limits will have no effect on most of operations. However it could make some difficulties, for example, in the process of maintenance, control, replacement, etc. in highly radiation areas. Particularly vurnable will be further use of "jumpers" in these processes. These new standards may also have some impact on the safety requirements regarding decommissioning and dismantling of some installations.

As mentioned above the present radiation safety philosophy distinguishes two radiation safety regimes: practices and interventions. Practice is any human activity that introduce additional source of exposure or exposure pathways or extends exposure to additional people or modifies the network of exposure pathways from existing sources, so as to increase the exposure or the likelihood of exposure of people or the number of people exposed. Intervention is described as any action intended to reduce or avert exposure or the likelihood of exposure to sources which are not part of a controlled practice or which are out of control as a consequence of an accident. The practices to which these new standards apply include all activities involving the production of radiation sources, the use of radiation and radioactive substances in industry, medicine, research etc., the generation of nuclear power including the entire cycle of related activities including radioactive wastes. On the other hand situations that may require intervention include chronic exposure to naturally occurring sources of radiation, radioactive residues from past activities and events, emergency exposure situations. Basic safety standards give detailed description on how radiation safety procedures need to be managed in both cases and what are requirements and responsibilities of operators and of regulatory authorities. It can be assumed that a couple of years will be needed for national competent authorities to introduce these requirements into their practices.

The introduction of potential exposure principle will require additional studies and data for each of possible accidents and overexposures. The safety levels associated with sources of potential exposure is usually established by the designers or operators of the installations and then judged by competent governmental organisations/ regulatory authorities. This is not a simple process and requires a serious assessment. There are two complementary techniques available to assess that an adequate level of protection against potential exposures has been achieved. These techniques are known as deterministic assessment and probabilistic assessment. Both methods are needed to ensure that an adequate level of safety has been achieved and that no major contributors to risk are overlooked. Usually deterministic methods are applied first to provide safety with appropriate safety margins in systems where scenarios leading to potential exposure are identified. As a second step probabilistic methods are then applied to identify weaknesses in the safety systems which otherwise might have been overlooked by the deterministic approach. These procedures are of special interest for complex installation such as radioactive mines, nuclear power plants, radioactive waste disposal facilities.

Most of operating installations which do not have the potential of nuclear reactors for causing large off-site public exposure and extensive off-site releases do not have operation centralised. Since processes and procedures are subject to frequent changes

these situations are often more susceptible to human error. Experience gained so far indicated that the workers themselves have a greater potential for exposure than the public in the vicinity of the installation. Therefore the emphasis in these safety analyses should be placed on assessments of human reliability, well-developed operating procedures, training and management surveillance.

Disposal of radioactive waste is a very specific case which leads to a radiation source which may extend over extremely long periods. As illustrated by ICRP this poses methodological problem connected with the assignment of probabilities to events and processes for potential exposure assessment. It need to be pointed out that assessment methods are still being developed and have not yet reached the same degree of maturity as, for example, PSA for nuclear reactors. Estimates of potential exposure will, to a great extent , depend on estimated probabilities for each scenario and critical event sequence within each scenario. Examples of such scenarios are early failure of waste containers or failure of the release delaying properties of the geological structure of the repository.

ICRP-64 precisely describes principles for regulatory activities in the context of potential exposures. It includes establishing a duty on the operating management to conduct assessments of the expected frequency and possible consequences of events, such as accidents and major errors of design and operation, that might give rise to doses substantially higher than those in normal conditions. The second step includes regulatory review. Depending on the likely scale of the problems posed by the events giving rise to potential exposures, the regulatory authority should establish a procedure for reviewing operator's assessments. Compliance with risk limits and constraints has to be judged from the results of assessment of the quality of the design, operation and maintenance of the facility and equipment and the quality of the management arrangements. Taking into account all these newly formulated safety recommendations and requirements relevant national authorities need to foresee relevant actions to ensure their smooth implementation. Among these actions principal tasks are: up-dating the relevant regulations, providing an adequate training on these new basic safety standards to regulatory staff and to operators of relevant installations and development of safety assessment practices. Also, they need to consider which installations should undergo re-licensing procedure in light of the new safety requirements.

Manufactured or important nuclear equipment need then to be checked whether their design and performance meet safety requirements.

References

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