VÉDELEM TUDOMÁNY
KATASZTRÓFAVÉDELMI ONLINE TUDOMÁNYOS FOLYÓIRAT

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APPLICATION OF DOSE CONSTRAINTS IN HUNGARY

Abstract

The purpose of radiation protection is to protect against ionizing electromagnetic and charged particle radiation. The main goal is to eliminate deterministic effects and to ensure that stochastic effects do not exceed the socially accepted risks of other occupations.

In this article, I will briefly present the 3 principles of radiation protection, justification, optimisation, and limitation.

After a brief overview, I will show with the principle of limitation in more detail. I am presenting recommendations and regulations for dose limits and dose constraints, with a little historical review. We can track how the radiation protection recommendations have evolved with the changing of the recommendations.

Keywords: Radiation protection, legislation, dose limit, dose constraint

A DÓZISMEGSZORÍTÁS ALKALMAZÁSA MAGYARORSZÁGON

Absztrakt

A sugárvédelem célja az ionizáló elektromágneses és töltött részecske sugárzás elleni védekezés. A legfontosabb cél a determinisztikus hatások kiküszöbölése, valamint az, hogy a sztochasztikus hatások ne haladják meg más foglalkozási ágak társadalmilag elfogadott kockázatát.

Ebben a cikkben bemutatom röviden a sugárvédelem 3 alapelvét, az indokoltságot, az optimálást, valamint a korlátozást.

A rövid áttekintés után a korlátozás elvével foglalkozom részletesebben, amikor is a dóziskorlátokra és dózismegszorításra vonatkozó ajánlásokat és szabályozást mutatom be, egy kis történelmi visszatekintéssel. Az ajánlások változásával végig követhető, hogyan fejlődtek a sugárvédelmi ajánlások.

Kulcsszavak: Sugárvédelem, szabályozás, dóziskorlát, dózismegszorítás

1 INTRODUCTION

With the amendments of Act CXVI of 1996 on Atomic Energy (hereinafter: the Atomic Act [1]), the Hungarian Atomic Energy Authority (hereinafter: HAEA) became the main licensing and supervisor authority from 1 January 2016 in the field of radiation protection. As a result of modification of the competences a review of the legislation had to be carried out. The Ministerial Decree 16/2000 (VI. 8.) of the Minister of Health on the Implementation of Certain Provisions of the Act CXVI of 1996 on Atomic Energy was the implementing regulation of radiation protection, the foundations of implementing regulation were laid together with the creation of the Atomic Act. Since its entry into force, international recommendations and European Union directives have also been issued, which have necessitated a review of the requirements had to be carried out. [2]

As a result of the review, Govt. decree 487/2015. (XII. 30.) on the protection against ionizing radiation and the corresponding licensing, reporting (notification) and inspection system entered into force on 1 January 2016, which replaced Decree 16/2000 EüM in several areas. In this way, the requirements for dose constraint were included in the new government decree. [3]

In the meantime, in addition to the significant number of existing domestic nuclear facilities, we plan to expand the nuclear power plant units, therefore periodic evaluation of the research and development results of nuclear safety and security is essential for successful preparation and defense.

Meanwhile, in addition to the significant number of existing domestic nuclear facilities, nuclear power plant expansion is being planned, therefore periodic evaluation of the research and development results of nuclear safety and security is a prerequisite for successful preparation and protection.

The development of nuclear power plants is significant worldwide, despite of the use of nuclear power plants has declined slightly despite as a result of the Fukushima accident. This development is presented by Manga et al in their article, where they show that nuclear power generation plays an increasingly important role among energy producers, so that more and more nuclear power plant units are being built and put into operation worldwide. [4]

2. ANALYSES OF THE PRINCIPLES OF RADIATION PROTECTION

There are three principles of radiation protection, which are developed by the International Commission on Radiological Protection (hereinafter: ICRP). The principles were presented in the 26th publication of the ICRP. [5]

i. Justification:

According to the principle of justification, an activity involving the use of ionizing radiation may be authorized only if the total benefits is greater than the harm caused by the radiation, that is the exposed person or society has an advantage which outweighs the disadvantages caused by radiation.

According to ICRP publication 103, justification is not a purely radiation protection but a broad, social task. Simply put, the data are provided by radiobiology and radiation protection specialists to estimate the harmful effects of radiation, but the usefulness can already be determined by the doctor proposing the treatment, or even by the government, parliament or the entire population in the case of nuclear power plant construction. [6]

ii. Optimisation:

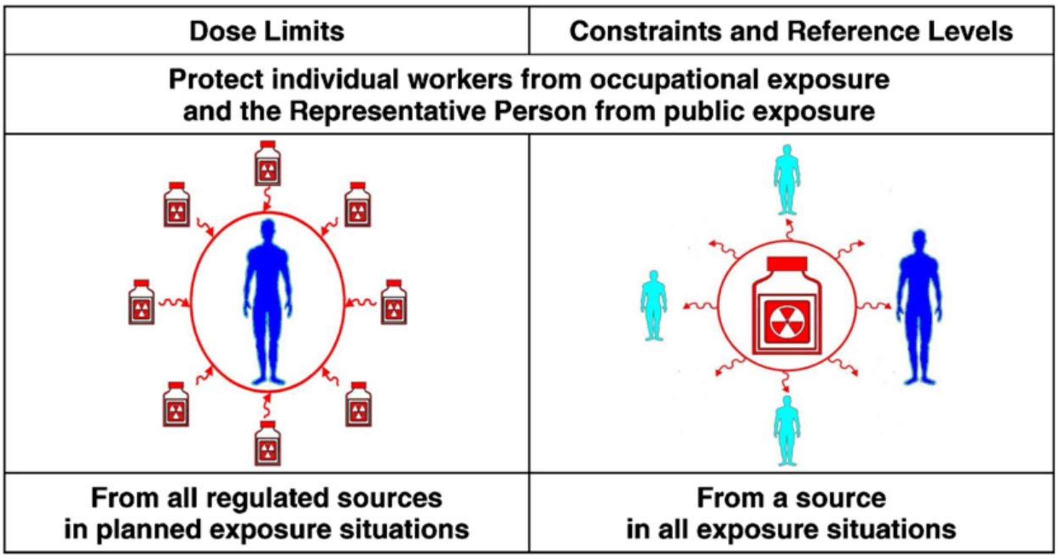
The principle is based on the fact that there is no permissible dose, but even within the limits a reasonable reduction of radiation exposure must be sought. Accordingly, protection and safety must be optimized so that the magnitude of the radiation exposure, the number of persons exposed to the radiation and the probability of the radiation exposure remain at the lowest reasonably achievable level. Economic and social factors must also be taken into account. This principle is also commonly referred to as the ALARA principle.

iii. Limitation:

The third principle is dose limitation. To put it simply, the dose limits set out in the regulation should not be exceeded by the combined radiation exposure from artificial sources. This does not include radiation exposures from medical applications.

Dose constraints for each source are also included. This means a dividing by source of dose limits for the public or workers. ICRP Publication 60 introduced the concept of dose constraint in order to demonstrate compliance with population dose limits. By limiting the doses from the different sources, compliance with the dose limit can be ensured. The determination of dose constraints for public is the competence of the national authorities. [7] [8] [9]

The 1. Figure help to understand the definition of dose constraints and the dose limits. The dose constraint applies to radiation exposure from all sources, while the dose constraint applies to a specific source.



1. Figure: Dose limits contrasted with dose constraints and reference levels for protecting workers and members of the public [10]

3. PRINCIPLES OF RADIATION PROTECTION IN THE HUNGARIAN REGULATIONS

The principles of radiation protection are contained in the Decree on the Implementation of the Atomic Act, which is the 487/2015 (XII. 30.) Government Decree. [1] [3]

At first the justification appears, which is regulated as follows in Section 5:

„(1) The use of ionising radiation shall be justified.

(2) A protective measure are justified to be introduced in an existing exposure situation or emergency exposure situation, if it entails more good than harm. " [3]

The requirement for the optimisation of radiation protection is contained in Section 7 of 487/2015 Government Decree:

„7. § Radiation protection of individuals subject to public or occupational exposure shall be optimised with the aim of keeping the magnitude of individual doses, the likelihood of exposure and the number of individuals exposed as low as reasonably achievable taking into account the current state of technical knowledge and economic and societal factors." [3]

The prescription of the dose limit is contained in Section 10 of 487/2015 Government Decree:

„10. § In planned exposure situations, the sum of doses to an individual shall not exceed the dose limits laid down for occupational exposure or public exposure." [3]

It can be seen from these that the legislation also regulates in accordance with the triple principle presented above.

4. DOSE LIMITS

4.1 Dose limits for public

In 1956, the annual dose limit for public was set at 5 mSv based on ICRP recommendations. Subsequently, in the framework of a review, this value was reduced to 1 mSv, as recommended by ICRP publication 60, with the possibility that this value could be the average of 5 years. This recommendation is also used by the Recommendation of IAEA GSR Part 3. [7] [11] The European Union set the dose limit for public at 1 mSv per year according to the Council Directive 2013/59/Euratom, tightening it somewhat. Adaptation had to be completed by 6 February 2018. Government Decree 487/2015 already applies the dose limits for workers in Table 1, taking into account the recommendations of ICRP Publication 103 and the requirements of Council Directive 2013/59 / Euratom. [3][6][12]

4.2. Dose limit for workers

In 1956, with the recommendations of the ICRP, the occupational dose limit was set at 50 mSv per year. The ICRP reviewed the dose limit after studying the survivors of the Hiroshima and Nagasaki atomic bombs, and then set the dose limit at 20 mSv in the ICRP Publication 60 based on a 5-year average and it could not exceed 50 mSv in any year. This recommendation is also used by the recommendations of IAEA.

The European Union has set the occupational dose limit at 20 mSv per year, according to the Council Directive 2013/59/Euratom. Adaptation had to be completed by 6 February 2018.

Following the recommendations and the directive, the requirements for the dose limit were developed in the Hungarian regulations. Thus, until the entry into force of Government Decree 487/2015, the dose limit was set by Decree 16/2000 EüM. 100 mSv for 5 years according to the regulation, in addition to not exceeding 50 mSv in any year.

Government Decree 487/2015 already applies the dose limits for employees in Table 1, taking into account the recommendations of ICRP Publication 103 and the requirements of the Council Directive 2013/59/Euratom. [2] [3] [6] [11] [12]

1. Table: The values of dose limit in 487/2015. Govt. Decree

	occupational exposure	apprentices and students	public exposure
effective dose	20 mSv/year	6 mSv/year	1 mSv/year

effective dose for whole life	400 mSv/life	-	-
lens of the eye	20 mSv	15 mSv	15 mSv
skin	500 mSv	150 mSv	50 mSv
hands and feet	500 mSv	150 mSv	**50 Sv**

5. DOSE CONSTRAINTS

The various organizations have formulated recommendations for dose constraint, the basis of which is the same in all cases, ie that the dose limit should not be exceeded, taking into account all irradiation scenarios of all sources.

The dose constraint for public should be an officially approved value, as previously written, while the occupational dose constraint is not necessarily. However, in order to comply with the dose limit, the target value must be an applicable and observable value.

The IAEA recommends the following for dose constraint:

„Dose constraints and reference levels are used for optimization of protection and safety, the intended outcome of which is that all exposures are controlled to levels that are as low as reasonably achievable, economic, societal and environmental factors being taken into account. Dose constraints are applied to occupational exposure and to public exposure in planned exposure situations. Dose constraints are set separately for each source under control and they serve as boundary conditions in defining the range of options for the purposes of optimization of protection and safety. Dose constraints are not dose limits: exceeding a dose constraint does not represent non-compliance with regulatory requirements, but it could result in follow-up actions.”

The Council Directive 2013/59/Euratom defines the concept of dose constraint as follows:

"*dose constraint" means a constraint set as a prospective upper bound of individual doses, used to define the range of options considered in the process of optimisation for a given radiation source in a planned exposure situation;*"

Then the Directive makes the following specifications.

„Article 6

Dose constraints for occupational, public, and medical exposure1.

Member States shall ensure that, where appropriate, dose constraints are established for the purpose of prospective opti-misation of protection:(a) for occupational exposure, the dose constraint shall be established as an operational tool for optimisation by the undertaking under the general supervision of the competent authority. In the case of outside workers the dose constraint shall be established in cooperation between the employer and the undertaking.(b) for public exposure, the dose constraint shall be set for the individual dose that members of the public receive from the planned operation of a specified radiation source. The competent authority shall ensure that the constraints are consistent with the dose limit for the sum of doses to the same individual from all authorised practices."

In some country the occupational dose constraints have introduced the values of into their regulations such as Slovak Republic, Greece, Ireland, or Belgium. Most of the European country give the possibility to the national regulatory body to set up dose constraints. In the third part of the European country the dose constraint for public exposure shall be licensed by the national authority, based on the proposal of the licensee.

According to the recommendation of ICRP Publication 103, the value of the dose constraint for public in effective dose should definitely be set below the dose limit, but e.g. in the case of radioactive waste disposal, it is worth choosing less than 0.3 mSv / year.[6]

According to the IAEA recommendation, it is advisable to set the value of the dose constraint so that it is below the dose limit, but higher than the exemption level (10 μSv), ie somewhere between 0.1 and 1 mSv per year.

5.1 Dose constraint in the Hungarian regulation

Government Decree 487/2015 contains the radiation protection requirements, including those related to dose constraint. The following definition of dose constraint is used:

„dose constraint: a constraint set as a prospective upper bound of individual doses, used to define the range of options considered in the process of optimisation for a given radiation source or a planned exposure situation;"[3]

As a result of the development of the authorities system, the special rules for nuclear facilities and radioactive waste storage facilities in Hungary are contained in Government Decrees 118/2011 and 155/2014. In 2018, the nuclear safety requirements were reviewed. I made a recommendations related to dose constraint to supplement the requirements. These recommendations are included in the article by Sebestyén et al. Since then, the legislation has been supplemented as a result of the review, including a review in line with IAEA recommendations. [13] [14] [15]

If we simply want to define what the dose constraint means and what its possible cases are, the detailed rules included in the Hungarian nuclear safety requirements, as well as the recommendations in the guidelines issued by the HAEA (AKFN4.23. Content of the Workplace Radiation Protection Rules for nuclear installations), will help to understand. [16]

"*The value of an occupational dose constraint can be applied to a facility, construction, or unit, but even to a specific workflow. It should be noted that in some cases the worker is not only in the given installation in radiation hazardous job position, therefore, its value should be set in such a way that, even with the resulting radiation exposure, it warns in time before the dose limit value is reached.*

All possible scenarios should be considered when determining the dose constraint, so both internal and external radiation exposure should be used."

That is, the dose constraint can be defined as the value of the design radiation exposure caused by a given source. It can be applied to different time intervals, either divided into work processes or to different parts of the facility (nuclear power plant unit, site) and used as an effective dose or an equivalent dose.

In the case of special facilities in Hungary, the dose constraints for the public are shown in the 2. Table. [17]

2. Table: The value of the dose constraints for public of the Hungarian special facilities

Facility	Dose constraint Effective dose
Paks Nuclear Power Plant (unit 1-4)	90 µSv/év
Spent Fuel Interim Storage Facility	10 µSv/év
Paks 2 (unit 5-6)	90 µSv/év
Budapest Research Reactor	50 µSv/év
Izotóp Kft.	50 µSv/év
Training Reactor	50 µSv/év
Radioactive Waste Treatment and Disposal Facility	100 µSv/év
National Radioactive Waste Repository	100 µSv/év
to restore the area of the closed uranium mine	300 µSv/év

In Hungary in the case of a special facility the licensee gives a proposal for the value of the dose constraint and the dose constraint for public exposure shall be licensed by the HAEA based on the proposal. In the case of occupational dose constraint, HAEA has not a licencing procedures directly. The Workplace Radiation Protection Rules is an authorized document by HAEA and it contains the dose constraint for workers. When the Workplace Radiation Protection Rules is under licencing procedures, HAEA is reviewing the value of the dose constraint for workers. [1] [3] Among the changes proposed by Sebestyén et al. Is that the following should be considered when licencing a dose constraint: [15]

(a) the nature and character of the radiation and the means of preventing it,

(b) regional factors; and

(c) the expected benefits.

Point (a) shall take into account the technical solutions available to avoid the radiation. Antal et al presented the implications of generations of nuclear power plants. With the development of each generation of nuclear power plants, the applicability of nuclear power plants becomes more and more safer, or, where appropriate, it retains radioactive isotopes more and more safely, even also under accident. Protection systems are installed to help protect. One such important change is the use of containment, which has been used since the 2nd generation reactors. Containment is briefly presented in another article by Antal et al. [17][20]

Different generations can also be taken into account in terms of expected benefits, as greater efficiencies are achieved during operation.

6. SUMMARY

In the article, I presented the principles of radiation protection and how they are applied by Hungarian regulations. In addition to the application of dose limits, I also presented the concept of dose constraint, which means the maximum radiation exposure from a given source for the members of public or workers.

As a practical application, Antal et al. briefly presented in their article [3][6][12] what aspects should be considered before the construction of a nuclear power plant during the study of optimization and justification. The first objective was to examine the construction of optimisation of construction and operation systems that could guarantee compliance with safety directives, and to set acceptable limits value for energy production to be economical.

In this article I have presented the values of dose constraint for public in the case of Hungarian special facilities which have been set as limit values authorized by an authority. Dose constraints for workers are approved in the authorization procedure of the Workplace Radiation Protection Rules. These values must be set in such a way as to ensure that workers who may work in more than one facilities can ensure that their annual exposure does not reach the dose limit. For this reason, the method used in the previous practice, according to which the licensee should use a value corresponding to the five-year average of the dose limit, is not appropriate. This was used as a fulfilment of previous requirements when the dose limit was given for a five-year time interval (while maximizing radiation exposure for one year).

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