AUTHOR'S PRESENTATION

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RESEARCH AND DEVELOPMENT OF POSSIBILITIES FOR MODERNIZING THE METHODOLOGY OF SITE EVALUATION AND RADIOLOGICAL ASSESSMENT OF NUCLEAR FACILITIES

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BUDAPEST

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THE FORMULATION OF THE SCIENTIFIC PROBLEM

As of January 1, 2016, the act created for the expansion of Paks Nuclear Power Plant (Act VII of 2015 on the investment project in relation to the capacity conservation of the Nuclear Energy Plant of Paks and modifying certain related acts) transferred radiation protection regulatory tasks to the competence of the atomic energy oversight organization (Hungarian Atomic Energy Authority, hereinafter: HAEA).

In line with this act, the competence of the HAEA was completed with the supervision of the radioactive materials and equipment generating ionizing radiation, the central collection, processing, registration and evaluation of data to be mandatorily measured in the environment, the determination of radiation protection monitoring obligations of workers, the registration of personal doses, the licensing of the trade of radiation protection tools and their radiation protection qualification, the approval of the thematic of radiation protection training and further training and their exam requirements, and the establishment of dose limits and approval of dose constraints.

With the integration of regulatory competencies nuclear safety, radiation protection and physical protection belonged to the same authority. The goal was to establish a single-level customer-friendly authority having nationwide competencies, in order to simplify the application for and issuance of licenses, to reduce the number of proceedings per licensee, and to standardize the data provided by users of atomic energy.

In order to implement the act, the Govt. decree 487/2015. (XII. 30.) on the protection against ionizing radiation and the corresponding licensing, reporting (notification) and inspection system (radiation protection decree, hereinafter: Rpd.) entered into force, which was meant to replace the previous general radiation protection decree (Ministerial Decree 16/2000 (VI. 8.) EüM of the Minister of Health on the Implementation of Certain Provisions of the Act CXVI of 1996 on Atomic Energy, hereinafter: EüM decree 16/2000). Among the goals of the new radiation protection regulation were to replace the 16/2000 EüM regulation in accordance with the change in authority, and to comply with international recommendations, including the Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom (hereinafter: EU BSS), which is mandatory from February 6, 2018.

From 2016, the Government Office of Budapest Capitol was responsible for radiation health issues, as a successor of the previous health authority, namely the Office of Hungarian Chief Medical Officer.

However, the scope of the implementation decree did not cover appropriate regulations corresponding to special recommendations concerning nuclear facilities and radioactive waste repositories, because the radiation protection regulations for nuclear facilities and radioactive waste storage facilities were established under the nuclear safety competence. Thus, when radiation protection regulation for radioactive material came into force (not technical radiation protection, as it was previously under the scope of the HAEA) an incomplete regulation was created.

It should be emphasized here that during the creation of the new radiation protection regulation, it was not intended to change the special requirements, which applied only to nuclear facilities and radioactive waste storage facilities.

The revision and modernization of the requirements was also necessary because in the recent decades the development of new international recommendations and guidelines and revision of existing ones was such extensive that justified the revision of the regulatory requirements for nuclear facilities and radioactive waste repositories.

From the presentation of the actuality of the thesis, it became clear that the regulatory system developed as a result of the changes in the radiation protection authority system a scientific problem occurred. It is necessary to further develop and modernize the radiation protection regulatory system, based on the following arguments.

1. The requirements for nuclear facilities and radioactive waste storage facilities did not fully meet the international radiation protection recommendations and guidelines, for this reason, the development and research of the regulation was necessary. The Hungarian regulation system requires the use of a single regulation with regard to the practical application of radiation protection requirements. In the case of nuclear facilities and radioactive waste storage facilities the regulatory system introduced with the change of scopes did not distinguish the applicable workplace radiation protection rules from other applications or from each other.

2. With the change of scopes, such errors and inconsistencies were formed that made necessary to develop the regulation regarding the classification of radioactive wastes. In the meantime, the international recommendations were also revised and new aspects were added to the proposed classification system. All of this showed that the international recommendations and national practices had to be aligned, and thus the radioactive waste classification system needs to be revised.

3. The previous radiation protection inspection authority system did not ensure the implementation of inspections with the appropriate level of detail in the case of special facilities. This was also demonstrated by the recently accomplished international mission aimed at reviewing the Hungarian regulatory system. Examining the main tasks of the authority, it can be concluded that a deficiency can be discovered in the inspection function of the authority.. The HAEA has the opportunity and ability in this regard, therefore the research and development of a procedure and method becomes a priority.

RESEARCH HYPOTESES

1. Based on my assumption concerning nuclear facilities and radioactive waste repositories the radiation protection legislation does not treat adequately these special facilities. The regulation dealing with radiation protection of various international organizations and bodies should be assessed together with the Hungarian experiences and possible improvements should be determined for the further development of regulations. Furthermore, in my opinion, the practical application of the radiation protection requirements is not uniform in the case of different nuclear facilities and radioactive waste storage facilities, although most of the requirements are the same.

2. According to my assumption, with the introduction of centralized radiation protection supervision and the amendment to the legislation, the classification of radioactive waste is not sufficiently regulated. Based on the analysis and evaluation of the international recommendations and practices, as well as the domestic legal environment, a proposal can be prepared for the development and application of the domestic regulations related to the classification of radioactive waste.

3. In my opinion, the domestic regulatory inspections do not apply state of the art radiation protection technical solutions in the nuclear power plant, they merely examine procedures of the licensee and the documents prepared by Paks Nuclear Power Plant.

RESEARCH OBJECTIVES

1. My first objective is to assess the adequacy of the domestic application of the recommendations of international organizations such as the International Atomic Energy Agency (IAEA) and the European Union (EU) in order to reveal possibilities for the development of domestic legal regulations, and then propose the application of appropriate legal regulations. The Workplace Radiation Protection Rules (WRPR) are used for the practical application of the radiation protection requirements for nuclear facilities and radioactive waste storage facilities, and require a uniform assessment based on the content elements to be defined.
2. My second objective is to identify and analyse the shortcomings resulting from the transformation of the domestic regulatory system, to examine the applicability of recommendations of international organizations, to study international practices, in order to examine the development possibilities of domestic regulations and propose the application of appropriate legal regulations.
3. My third objective is to develop a regulatory inspection method that can be used to assess the radiation protection condition of the nuclear power plant from technical viewpoint to draw conclusions regarding radiation protection arrangements in any operating condition of the nuclear power plant. The technical steps should be as simple as possible.

RESEARCH METHODS

In order to fulfil the above defined research objectives, I applied the following research methods during the development of the thesis - in line with my four-year research plan:

1. During my research, in accordance with my objectives I used the generally applicable research methods, including analysis, synthesis, induction and deduction.
2. With due care and striving for completeness - to the extent appropriate to the research problems - I analysed the international, European Union, and domestic legal and internal authority (HAEA) regulations. In addition, I performed an evaluation and analysis of the relevant foreign and Hungarian literature.
3. Applying analytical and logical methods I formulated proposals to evaluate the current regulations, the internal operator and official procedures, and law enforcement activities, and drawn conclusions.
4. Empirical research methods were used based on my professional experience in the field corresponding to the researched scientific problems.

5. Participation in domestic and foreign further training, conferences, and professional meetings provided the opportunity for me to obtain information that not only assisted my research, but also collected data for the preparation of my thesis.

6. Professional consultation in the field of radiation protection with recognized domestic and foreign experts in professional and scientific circles made possible to discuss my work assumptions.

7. I published my reserach results at domestic and international professional and scientific conferences.

8. Based on the comments and feedback given on the publication of my results, I partially adjusted my research concept in the direction of narrowing and concretizing the topic.

BRIEF DESCRIPTION OF THE STUDY CARRIED OUT BY CHAPTER

In the first chapter, I present the documents of the recommendations developed by international organizations, in the framework of which I evaluate the actuality of the amendments to the domestic regulations. I do this in the framework of a summary and organized study. I also deal with the consequences of the change in the Hungarian radiation protection authority system, and then examine the areas in which regulation development is necessary. After that, I analyse the documents of international organizations in detail, in the frame of which I make a comparison with the domestic radiation protection regulations in the framework of a SWOT analysis and develop the missing regulatory provisions that are missing from the domestic regulations. From the proposals, I prepare a guide regarding the content requirements of the Workplace Radiation Protection Rules.

In the second chapter, I review the method of radioactive waste classification in the domestic regulations. For this purpose, I present the domestic regulations, as well as the main producers of radioactive waste, i.e. the Hungarian nuclear and radioactive waste storage facilities. During the investigation, I examine established domestic practice, international examples, and the recommendations of international organizations, which I detail in the chapter. After that, I present my proposal for the development of the domestic application. I also demonstrate in this chapter why my proposed system is more modern and more usable than its predecessor.

In the third chapter, I examine which radiation protection authority tasks may still need development, for this I analyse the main regulatory tasks. After that, I present a new element of the supervision method that I developed in relation to the nuclear power plant, which is a general-purpose radiation protection inspection combined with radiation protection measurements. The method was inspired by a review mission conducted by the IAEA, which drew my attention that the HAEA does not carry out effective radiological inspections at the nuclear power plant. Among other things, I briefly present the nuclear power plant systems that are affected by the official supervision method, the inspection method that I have developed including the perfomance of radiation protection measurements. At the end of the chapter, I present the results of the method I have carried out, and in the framework of a short evaluation, I give an account of the results of the method obtained so far.

SUMMARIZED CONCLUSIONS

I. Evaluation and development of a radiation protection regulation system

In the first chapter, my main goal was to assess the appropriateness of the domestic application of the recommendations of international organizations (IAEA, EU), as well as the possibilities for the development of Hungarian regulations, and to evaluate the domestic radiation protection authority system, on the basis of which I drew to the following summarized conclusions:

1. I examined what changes have occurred in the structure of the radiation protection authority system in the recent decades. Based on this examination, I presented the changes in the regulatory system and legislation induced by the modification of auhtority competencies. I came to the conclusion that the development of the regulation is necessary due to the transfer of the previous radiation protection supervision competence.
2. I examined the regulatory system, in the frame which I came to the conclusion that development and modernization are necessary, because the domestic radiation protection requirements are general, the specific recommendations of the IAEA are not fully taken into account, and the revision of the nuclear safety requirements was required by a legal requirement.

3. The change in scopes of regulatoy competencies was followed by the amendment to the legislation, thus instead of the EüM. Decree 16/2000., the Government Decree 487/2015, then HAEA Decree 2/2022 on the protection against ionizing radiation and the corresponding licensing, reporting (notification) and inspection system came into force, as well as the Government Decree 118/2011 on the nuclear safety requirements of nuclear facilities and on related regulatory activities was followed by the HAEA Decree 1/2022. and the Government Decree 155/2014 on the safety requirements for facilities ensuring interim storage or final disposal of radioactive wastes and the corresponding authority activities was followed by the HAEA Decree 9/2022.

4. I presented the IAEA publications, which were necessary to be examined in order to achieve the goal.

5. I presented the grouping used for my proposals for amending the legislation, I also presented the proposals themselves as an annex. The research resulted in a large number of proposed amendments. In some cases, the proposal turned out to be too detailed to publish in legislation, so I recommended using them separately in the preparation of a later regulatory guidance document for radiation protection purposes.

6. The proposals were incorporated into the legislation, they became requirements effective in 2018. As one of the results of my research, I managed to complete the legislation with special radiation protection requirements.

7. I found that the requirement for the content for the WRPR located in the Rpd. cannot be applied to nuclear facilities and radioactive waste storage facilities, so as part of my first scientific result, I moved the requirements for the content to the nuclear safety requirements.

8. During my research, I came to the conclusion that consideration of the Workplace Radiation Protection Rules as a modification licence document and as a basic operating document at the same time is a unique solution.

9. The Workplace Radiation Protection Rules are used for the practical application of radiation protection requirements for nuclear facilities and radioactive waste storage facilities, which require a unified assessment. In order to develop such assessment, I considered the preparation of the content elements to be my objective, and thus I have prepared the corresponding guide.

10. The authority guidance containing recommendations for the content of the Workplace Radiation Protection Rules was issued by the former Director General of the HAEA, which was revised by me and then published as an effective guidance on the HAEA website.

Based on my findings above, ***I see the fulfillment of my hypothesis Nr. 1 as verified, which substantiates my scientific research result Nr. 1.***

II. Evaluation and development of the radioactive waste classification system

In the second chapter, my main research objective was to examine the domestic radioactive waste classification system, based on which I came to the following summarized conclusions:

I found serious deficiencies in the domestic regulations regarding the radioactive waste classification system.

1. I examined the requirements for the classification of radioactive waste and found that the requirements are not comprehensive. It contained the waste classes, but the requirements to be applied were missing.
2. I described the radioactive waste classification system included in the recommendation of the IAEA, which divides radioactive wastes into 6 groups.
3. After analysing the classification system recommended by the IAEA, I found that it does not match in all details to the table appearing in the domestic regulations. I came to the conclusion that the domestic system:
    a) does not use the very low level waste class,
    b) does not properly apply the very short lived waste, because it cannot meet the recommendation in all respects,
    c) the criteria for high level waste are not clear, they must be clarified.
4. According to the National Programme, the classification of the very low level waste had been introduced in 2018.
5. I presented the basic parameters of nuclear facilities and radioactive waste storage facilities, then I found that my research work is relevant in terms of my topic, because the construction of two new units at Paks will result in the generation of even larger amounts of waste.
6. I also examined international examples in order to identify good practices and reshape the domestic regulation. I selected five states, examined their practice, and then I concluded that the domestic practice is compatible with foreign examples.
7. Another goal was to present the classification system what I proposed.

8. It can be concluded that it was a success to create a classification system that can be compared to the current domestic practice, takes international recommendations into account and can be well compared to international practice through international examples.

Based on my findings above, ***I see the fulfillment of my hypothesis Nr. 2 as verified, which substantiates my scientific research result Nr. 2.***

III. Development of domestic radiation protection authority inspections at nuclear power plants.

In the third chapter, my main research objective was to strengthen the radiation protection regulatory supervision by developing an inspection method. I came to the following summarized conclusions:

1. Due to the division of radiation protection competencies, the radiation protection inspections did not cover all areas. Due to the change of regulatory competencies in 2016, radiation protection inspections were not performed by the health sector, so the HAEA solved the radiation protection inspection of the facilities under its supervision. Due to the previous dual authority system and then the change of competencies such a situation occurred where the HAEA had to provide resources for radiation protection inspections as well.

2. In 2015, an IRRS mission took place in Hungary, in the framework of which a team of international experts from the IAEA reviewed the effectiveness of the Hungarian authority system. The mission was preceded by a preparatory phase when a self-assessment had to be performed by answering predetermined questions. The mission provided a number of recommendations and identified good practices. One of the recommendations dealt with the established inspection practice; it recommended to carry out an inspection in the nuclear power plant that includes radiation protection measurements.

3. I described the authority tasks in order to determine further areas for potential development in addition to the development of the regulation made in the first chapter. I have classified the regulatory tasks into five groups, such as licensing, inspection, reviewing, enforcement, regulation development. I determined three tasks requiring further development, because due to the duality of radiation protection regulations, the regulatory supervision was not properly carried out regarding the task or it was not properly regulated. As a result, I found that:

a) Legislation needs to be improved, because the recommendations of the IAEA for special facilities were not taken into account. I completed this task and presented the results in the first chapter.
b) The development of licensing is necessary, because with the modification of scopes, such a requirement was established for the content of the basic rules of radiation protection at nuclear facilities and radioactive waste storage facilities, which was not implementable. Therefore, the licencing procedure also needed revision as I described in the first chapter.
c) It is necessary to improve inspection, because the imprecisely formulated tasks of the dual radiation protection authority did not adequately cover the nuclear power plants. Until now, the HAEA had not carried out inspections with radiological measurements, and there was also a lack of a comprehensive radiation protection inspection, which can be used to assess the radiation protection condition of the nuclear power plant. During the inspection, compliance with the administrative measures must also be checked in accordance with the rules of the WRPR.

4. During my research work, I set up a system of criteria, which provides a suitable framework for the development of inspection. In this context, among other things:

a) I have determined the measurement points where I can get relevant information about the condition of the unit.
b) In this context, I presented the main systems of the NPP, including their most important properties, which are suitable for carrying out the measurement.
c) I determined the measuring method using measuring instruments of HAEA.
d) During the inspection, a comprehensive radiation protection condition survey must also be carried out, this can be done by checking the condition and authenticity of the radiation portals and measuring instruments.
e) I came to the conclusion that the inspection should be based on a simple measurement method and subsequent evaluation in order to fulfil inspection goals, and so that unreasonably large resources shall not be reserved.

Based on measurement results, I concluded that the method is suitable for achieving the prescribed goals, i.e.

- it should indicate deterioration in the condition of the unit,
- it should indicate the presence of an inhermetic fuel assembly,

- it should even be carried out during normal operation,
- the measurement and the evaluation of the measured values should be simple, and
- the method should take into account the availability of measuring instruments.

Based on my findings above, ***I see the fulfillment of my hypothesis Nr. 3 as verified, which substantiates my scientific research result Nr. 3.***

NEW SCIENTIFIC FINDINGS

1. Based on the examination of the relevant international publications on radiation protection, the authorities and their competences, I developed the conditions for the domestic legal and technical application of radiation protection and made a recommendation for the development of radiation protection regulations, the implementation of which sustains the radiation protection activities of the facilities under the regulations at a high level.

Based on my research covering the international comparative study of the domestic radiation protection requirements in the workplace and their practical application, I have developed an authority guidance for nuclear facilities and radioactive waste storage facilities, which can serve their safe operation with a uniform appearance of radiation protection rules.

2. Based on the analysis and evaluation of the international recommendations and practices, as well as the domestic legal environment, I determined the shortcomings of the legal system of norms concerning the domestic classification of radioactive waste and I developed the requirements for the regulation of radioactive waste, the application of which provides the legal basis of the radiation protection related regulatory activity.

3. During the research of radiation protection inspection methods and their practical implementation, taking into account the technical characteristics of the VVER-440 type nuclear power plant, I developed a radiation protection inspection methodology based on the authority's technical tool system, which enables the investigation of the radiation protection technical situation related to the operational status of the nuclear power plant and the determination of its adequacy.

RECOMMENDATIONS

1. Among the authority functions, I did not make a recommendation for the assessment, because the radiation protection evaluation can also be included in the assessment, however, I recommend the analysis and assessment of the evaluation tasks in order to identify development possibilities for the radiation protection evaluation.

2. In the case of nuclear facilities and radioactive waste storage facilities, no radiation protection guidelines have been prepared yet. The results of my research can be used during the preparation of a new guidance on radiation protection.

3. Two low- and intermediate-level radioactive storage facilities were established in Hungary. Nuclear power plant waste can only be transported to one of them, while the other receives institutional waste. With the classification of radioactive waste, the very low level waste category was also established in Hungary. As a consequence, nuclear power plant waste is sent to a geological repository even if it is classified as very low level waste. The establishment of a very low level waste storage facility would definitely be justified, so that the geological waste storage facility is not loaded with waste that could be placed in a very low level waste storage facility.

4. In order to achieve point 3, the legislation must be further developed as the requirement system for low- and intermediate level waste storage facilities should not be applied to a very low level waste storage facility.

5. The method of radiation protection inspection, which I developed, was designed for the nuclear power plant. After further development of the method, I recommend the development and use of a similar method of radiation protection inspection for other nuclear facilities and radioactive waste storage facilities also, taking into account the safety importance of the facility.

THE PRACTICAL APPLICABILITY OF RESEARCH RESULTS

I recommend using the conclusions, findings, proposals and specific research results of the research topics discussed in the thesis as follows:

1. Some of my proposals for the modification of the radiation protection legislation have already been included in the legislation containing nuclear safety requirements (Government Decree 118/2011, Government Decree 155/2014), at the same time, another part of it was not included in the legislation during the professional discussions, because it would have turned out to be too detailed for a requirement and would rather be in a guidance. My suggestions can be used to prepare such a guidance.

2. I prepared a guidance to the content of the Workplace Radiation Protection Rules for nuclear facilities and radioactive waste storage facilities. The guidance can be used when developing the WRPR for these facilities.

3. My proposal for the classification of radioactive waste had been incorporated into Annex 12 of Government Decree 487/2015, which contains general radiation protection requirements, so its practical applicability is demonstrated by the new system for classifying radioactive waste.

4. I developed an authority inspection method for the nuclear power plant, which can be used to make a quick assessment of the condition of the unit. The use of the method is further recommended, and it can also be used as a basis for other nuclear facilities.

LIST OF PUBLICATIONS PREPARED BY THE PHD CANDIDATE

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PROFESSIONAL-SCIENTIFIC CURRICULUM VITAE OF THE CANDIDATE

Name: Zsolt Sebestyén

Place and date of birth: Dombóvár, 21.12.1982.

Studies: He graduated at the Budapest University of Technology and Economics as a certified engineering physicist, specialisation in nuclear technology. He completed the primary circuit mechanical engineer course at Paks NPP, passed the public administration examination in the Foreign and Security Policy sector, and obtained a comprehensive radiation protection qualification.

Language skills: He has an intermediate level exam in English and a basic level exam in German

Professional career: He started his professional career at the National "Frédéric Joliot-Curie" Research Institute for Radiobiology and Radiohygiene (NRIRR), where in addition to theoretical research activities, he was also involved in radiation protection in practice, both in terms of industrial and medical applications. He became a duty officer of the National Health Physics Stand-by Service and then the deputy radiation protection officer of NRIRR.

In 2013, he joined the Hungarian Atomic Energy Authority. In the beginning he dealt with safety assessments, reports, and event investigations, where during his work he developed the weighting method of HAEA applied to the safety assessment of events. With the modification of the competencies of HAEA, he increasingly dealt with radiation protection. The activities related to the management of radioactive waste closely related to radiation protection, as well as the supervision of radioactive waste storage facilities, became part of his tasks.

Scientific activity: During his work and scientific life, he became a member of the Disaster Management Section of the Hungarian Association of Police Science and the Radiation Protection Section of the Loránd Eötvös Physics Society. He regularly publishes in domestic and foreign professional journals, participates in specialized conferences, further trainings, technical meetings, and work meetings, where he gave numerous lectures. In the framework of EU projects, he delivered trainings for foreign specialists from Jordan, Ghana, and Bosnia-Herzegovina, where he presented the practice of the Hungarian radiation protection authorities regarding nuclear facilities and radioactive waste storage facilities.

Budapest, 29.08.2023.

Sebestyén Zsolt

Zsolt Sebestyén