AUTHOR'S PRESENTATION
OF DOCTORAL (PhD) DISSERTATION

UNIVERSITY OF PUBLIC SERVICE - LUDOVIKA
DOCTORAL SCHOOL OF MILITARY ENGINEERING

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Research and Development of Nuclear Emergency Management Requirements for the Establishment of a Nuclear Power Plant

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Budapest

September 20, 2022.

FORMULATION OF THE SCIENTIFIC PROBLEM

Today, electric energy has become an essential element of our lives that requires continuous generation as –for now- we are unable to store it in large quantities. Energy, which is easily produced and enables versatile use both in households and in industrial environment, plays a vital role in private and business areas. In Hungary, nearly 50% of the country's electricity consumption is provided by the electricity that is produced in the Nuclear Power Plant (hereinafter: NPP). In the last decades, electricity consumption has grown rapidly due to the development of technology and computing. Therefore, energy producers that are based on conscious planning and increased efficiency will be needed to meet these needs. Moreover, the application of these producers should not involve an increase in environmental damage. The gradually growing individual specific energy demand is the result of technological development and operational efficiency growth which require optimal and stable electricity production.

The safety of the NPP means that we have taken specific measures to ensure that the environment, the material assets and, above all, the health of the current and future generations are not endangered by harmful radiation above the accepted risk level. The optimal goal is to develop and create modern and efficient energy – generating technologies while keeping the factors of harmful environmental effects low.

Nowadays, it can be concluded that NPPs do not have harmful effects during their normal operation and do not cause environmental damage thanks to the advanced active and passive safety systems. Although, at the same time they are potential sources of danger, since they can cause an acute emergency in the event of special circumstances. Considering this, safe operation is the most important criterion. The environment, and primarily the facility's workers, must be protected from the radiation of the large amount of radioactive material in the reactors. In the reactor, a large amount of energy (the so–called residual heat) is released even after shutdown, as the decay of the radioactive elements continues. Therefore, three vital safety conditions must be met in nuclear reactors:

- the effective regulation of the nuclear chain reaction;
- adequate transportation of the produced energy;
- preventing the leakage of radioactive materials.

To ensure that a low level of risk is combined with a high degree of safety, during the planning and operation of the NPP, special attention must be paid to the appropriate design of the physical structure of the technological systems using modern technical solutions. The risk analyzes associated with the technical solutions can be considered complete when the amount of radioactive

emissions assigned to zone damage and individual operating conditions are determined together with the assumed starting event. In addition to technological failures, other external and internal dangers of other origins (e.g. fire, flood, earthquake, weather) are determined for these solutions. The malfunction and accident chain that develops in the event of possible safety protection system failures following the initial event can be determined by process simulation, which also includes the necessary and sufficient conditions for the successful intervention of the systems. To avoid the function-loss of individual systems, the logical conditions of failures capable of preventing successful interventions can be revealed through system analysis.

All processes belonging to safe operation, which may endanger the environment and our society, are classified under certain guidelines depending on the degree of danger. The resulting convention levels provide guidelines for the safe establishment and operation of technological, industrial systems and processes. The planning, construction and safe operation of an NPP until its decommissioning are based on requirements that meet the multi-level, parallel protection conditions already laid down in the planning phase. The fulfillment of the criteria does not rule out the occurrence of errors, as a result of which it is necessary to be able to categorize individual emergency situations into the respectively developed damage prevention procedures as soon as they occur. Therefore, both those involved in damage prevention and the disaster management specialists must have all safety-affecting information and prevention system cause-and-effect protocol correlations to carry out their tasks effectively.

It is part of the protection planning of the nuclear facility that those participating in the operational prevention have all the equipment necessary for the prevention of damage, which is necessary for the implementation of the individual procedures, and that they are aware of the cause-and-effect relationships of the damage event at all levels of protection and are prepared for the effects of the consequences, even before they occur. For this, it is necessary that, in addition to the skill-level knowledge of their own field, they should have comprehensive nuclear knowledge that covers the areas that represent safety risks of the NPP. They must know how the national or local specific measures and their classification levels are organically connected to each other, by discussing the connections and operational schemes.

The health protection of the operational staff involved in interventions requires special attention in addition to the technological and technical solutions for accident prevention to ensure that both the environment and people receive the most suitable situation-specific care possible, preventing the complications of damage effects and avoiding unjustified endangerment.

The most basic reason for this is that the Hungarian regulations primarily apply to nuclear facilities of older construction, even if the regulations do not formulate specifics, but requirements that can

be used to identify the basic requirements of facilities based on newer technologies. The safety and protection systems and system components operate as multiple parallel processes, ensuring the integrity of the operating states and, at the same time, each other's inviolable levels.

It is necessary to identify the technological innovations of the new power plants with the protocols of the old power plants and to further broaden them in a common system. The aim of the improvement is to develop effective guidelines by which the currently high level of security can be further increased but is at least equivalent to its maintenance. We find deviations and gaps in requirements for certain essential technological implementations of 3+ generation NPPs. If we take either the European AES-2006 or the Russian VVER-1200 type reactors, in each of them it is obvious that we can find an improved version of a mature technology, but they contain important developments that should be mentioned in the volumes of the Nuclear Safety Standards (hereinafter: NSS).

The Hungarian NSS volumes contain a list of requirements for all nuclear facilities that guarantee a lifetime safety from the first phase of planning to the final point of decommissioning and discharge of radioactive material. Although the development of technology does not cause a need for essential changes in requirement in terms of the NSS volumes, it is indispensable that new technologies, such as those encountered in connection with generation 3+ nuclear reactors, are analyzed in the light of the technological implementations of new facilities.

Nuclear facilities must also be analyzed from an operational point of view. The operational basis is the development of a management system that is carefully planned, meets the requirements and is always able to maintain the necessary level of safety. The carefully designed control systems provide the procedures related to the operating conditions, through which it is possible to know, in every situation, which process should be used to restore the standards included in the design basis. These systems are under continuous monitoring and advancement so that all critical situations can be covered and controlled by using the acquired experience.

It must be taken into account that non-conformances can occur during the operation of the systems, which must be identified within the planning design in order to avoid endangerment. To really achieve this, such processes must be developed which can model the consequences step by step so that the outcome is feedback that results in preventive- and repeat-avoidance protocols. The consequence of this, for example, is that NPPs' safety processes have been developed where reactor cooling can be operated using both active and passive systems, and the operation of the passive system does not require an electrical supply or human intervention. To make this happen, the design principles and requirements of the systems and system elements which are important for nuclear safety had to be precisely defined.

In the case of establishing two different generational NPPs, which have effects on each other, must not only be built according to guidelines from international experience, but local characteristics, the parameters of the territorial location and the cooling water source must also be added to these. Safe operation can only be achieved by procedures through which it can be proven that the operation of the new power plant, including its active and passive systems for all operating conditions, does not have a negative effect on the operation of the old power plant and vice versa, furthermore the development of a domino effect in any direction is prevented by all possible resource.

To use the Danube River as a primary source of cooling water, it is necessary to implement additional alternative solutions in addition to the existing ones, because it can result numerous unique problems in terms of the two NPPs' supply. The change in environmental and hydrological conditions, the ratio of water volume and water consumption, and the change in weather corresponding to the seasons raise serious problems even in relation to the current operating power plant. These cannot be combined with the parallel operation of two nuclear facilities on the Danube, without an effective alternative solution, which does not result in an abnormal operating condition.

RESEARCH HYPOTHESES

1. I believe that by combining the knowledge of NPP technology and nuclear accident prevention in a thematic manner, in addition to the general damage prevention procedures, I can prepare a detailed resource covering a range of educational and safety tools, which will result in relevant knowledge for Disaster Management professionals about what protocols and tools must be used for optimal efficiency.
2. I presume that the control systems of the existing Paks NPP and Paks II that is under construction need to be further developed in such a way that the transmission of information about the effects of events and the initiated procedures realize the transmission of real-time data to the organizations responsible for protection. Based on this development, it is necessary to expand the procedures for emergency situations.
3. In the name of nuclear safety, I assume the development of a combined Fire-fighting and Technical Rescue Plan (hereinafter: FTRP) for the two power plants. For this the relevant parts of the Comprehensive Emergency Management Action Plan must be expanded (hereinafter: CEMAP) along with the relevant parts of the Accident Prevention Organization (hereinafter: APO), supplemented by a proposal for the special expansion of the facility's fire department.

4. I believe that further development of the Severe Accident Management (hereinafter: SAM) procedures which are developed within the framework of the safety-enhancing measures of the four currently operating nuclear reactors is necessary due to the technological specifications and differences of the new generation nuclear reactors. The expansion of the order of the SAM feeding procedures will help to cover the targeted safety functions of both NPPs at the same time.
5. Based on the experience of the past years, I assume that the National Report on the Targeted Review of the Paks NPP, prepared by the National Atomic Energy Agency, needs to be expanded in connection with the establishment of the new NPP, so that the concept of the construction of peripheral protection devices is realized.

RESEARCH OBJECTIVES

The basic goal of my research is to use the summary of the existing safety requirements of the Paks NPP to determine what special disaster prevention safety requirements the new NPP, which is to be built on the same natural water source next to the existing power plant, must meet for it to meet international expectations.

1. I summarize the existing regulations related to the design, construction and operation of the NPP, so that by linking their essential aspects together, it results in a complex body of knowledge that can be understood and used by anyone in addition to their basic knowledge, even for educational purposes. I also research all the conditions that by using nuclear energy may arise for the Disaster Management, from risk factors to effects on society and the economy.
2. I determine the relevance and operability of the event-dependent protocols used during current accident management regarding two NPPs operating in the immediate vicinity of each other, with which I establish the basis for the implementation of development of a new system within the principles of protection systems.
3. My goal is to develop well-defined proposals for industrial safety and the two NPPs' parallel operation, which make the management of emergency situations, the occurrence of prevention tasks, preparation and defense against accidents more effective. The proposals to be developed affect legal, technical, procedural and official methodologies and rules.
4. I examine the nuclear accident prevention planning related to the parallel operation of the two power plants, define and analyze the currently operating measures and procedures, through

which I lay down development proposals for defining a new, complex security planning and precautionary system.

5. In the light of my experience in the profession and recent events affecting nuclear technology, I draw conclusions about the current effectiveness of the existing procedures and to improve them I formulate well-founded expansion proposals using the existing regulations and technological knowledge materials.

RESEARCH METHODS

To achieve the set goals, I used the following research methods:

1. By studying the relevant literature, I examined the regulations of domestic and international nuclear facilities and the criteria that are essential for the thorough planning, efficient construction and safe operation of an NPP. The international and domestic directives define the pivotal points on which the safety system of a NPP can be built, especially in the case of the operation of several nuclear facilities that are physically close to each other and, through their technological implementation, the same a water source supplies them with cooling water.
2. By examining the international and domestic legislation and guidelines, I would like to establish the relevant points with which I would like to propose the expansion of the procedures and guidelines I have chosen.
3. Through consultations with the experts of the Paks NPP, by assessing the local characteristics and visual inspection of the technological implementations, as well as by testing the specifics of the associated operating options, I would like to acquire the knowledge from which I can shape proposals, combined with personal experience using scientific publications.
4. By getting to know the operation of the technological systems for the new power plant, I want to explore the industrial safety points that I derive from my existing technological knowledge of the old power plant, using the corresponding internal technological controllers.
5. I want to use the experiences related to the extreme weather conditions of the past years, including the effects of low and high-water levels and the possibilities of protection against extreme icing.
6. I have contacted the organizations commissioned with the construction of the new power plant, and I am also in direct correspondence with the Russian company ROSATOM, regarding the definition of technological solutions and new technological parameters, which have an influence on the development of Disaster Prevention requirements.

7. I continuously use the existing and expanding professional knowledge base to thoroughly explore the relevant issues and use the existing experiences to determine the broadest spectrum of problems and possible solutions.

BRIEF DESCRIPTION OF THE COMPLETED EXAMINATIONS BROKEN DOWN BY CHAPTERS

The role of the **first chapter** is twofold. First of all, the basic definitions and regulations of NPPs are explained, as well as the dangers associated with planning and operation. Based on this, I am developing a Nuclear Emergency Management Manual in connection with the basic knowledge of the NPP's technology and nuclear accident prevention for Industrial Safety specialists, supporting its necessity for Disaster Management. In order to properly transmit professional knowledge, I am building an educational syllabus for the manual, which uses the chapter's content and the relevant annexes to implement multi-level knowledge broadening.

The **second chapter** will discuss the relevant and necessary development of the real-time communication and event response impact factors of the two Paks NPPs, in which I will establish the foundations of the Operating-status Monitoring System (hereinafter: OMS), with the conditions of the associated implementation requirements, with which it will be possible to operate a system for transmitting real-time operating status information. I would like to upgrade and file the information data sheet for the regularized emergency assessment used by the Engineer in Charge and the Plant Control Center (hereinafter: PCC) duty manager as part of the development procedures. For the usability of the Operating-status Monitoring System, I determine the possibilities of technological interventions, parallel it with real-time information transmission for the security organizations involved in situation management. Moreover, I also establish the basic conditions for the energy supply and operation of the monitoring system. I make a recommendation for the upgrade and expansion of the program of immediate response measures for the Emergency Departments. I design the user interface and the criteria for operation of the OMS.

In the **third chapter**, I work out multiple developments and updates for the complex emergency planning of the two parallel operating NPPs. In connection with CEMAP, I define the expansion directions and goals with which I lay out the two side-by-side functioning NPPs' operating procedure accomplishment. I develop the criteria for the structural upgrade of the expanded and consolidated APO, from which I deduct the operational aspects of a new kind of so called contributory APO. I compose a development to modify the APO alarm sequence to fit to the extension I have proposed. I develop a recommendation for the construction of a combined and equipped Safety Management Location (hereinafter: SML) which can meet the requirements of

both NPPs in a critical situation. In connection with the expansion of the APO, I determine the structure and operational criteria of the parallel operating APO, and in connection with this, I develop and analyze the concept of an upgrade of the facility's fire department in association with its supported force-equipment development recommendation, so it can completely fulfill the protection for both NPPs. To improve the efficiency of damage prevention, I worked out the design criteria system for a combined FTRP, by combining its expansion, elaboration and development.

In the **fourth chapter**, within the safety-enhancing improvement of the two parallel operating NPPs, I establish relevant developments for expanding the SAM procedures. I recommend the extension of the SAM supply system between the two NPPs and the development of the SAM procedures arising in connection with this in a joint system. I determine the development direction of the current SAM guidelines, so that even after the loss of the final line of defense of the two parallel operating NPPs remain able to offer an alternative for nuclear accident prevention that can be effectively implemented. Due to the technological difference of the new NPP, the concept of air cooling SAM system of the double-walled containment will be developed, which is an upgrade that currently does not exist because of the technological coefficients. I compose a proposal for the development of power and equipment necessary for the united SAM and construction for alternative water sources, to form the cold-water feed channel of the new NPP and a feasible concept of an artificial water reservoir support. I also verify the existence of the knowledge of situation management based on the first chapter as targeted expertise for operational managers and executors as an essential aspect, and I also refer to the additional possibilities of using the OMS in relation to SAM situations. I conclude that the expanded SAM requires an increased situation management potential, which supports the need to increase the number of fire brigades I have defined earlier.

The **fifth chapter** lines up conclusions in connection with the concept of the peripheral protection construction for the two parallel operating NPPs. I also present aspects to improve the flood protection concept of the Paks NPP. I compose a professional reminder to maintain the current principle of earthquake resistance and to its development direction for the two NPPs' parallel operation. Its contents include the strengthening of technologically relevant points, the placement and management of SAM devices, the construction of the joint earthquake-proof SML and shelter, as well as the earthquake resistant parameters of the radio system. In relation to earthquakes or extreme situations, I refer back to the possibility of using the OMS, if any damage would result in the failure of the normal communication channels. In relation to the area of the new NPP, I outline a flood protection upgrade, for which I determine the criteria which are necessary already at the construction stage. With regard to extreme weather situations such as icing and extremely low

water levels, I propose the development of the safety documentation parts and thereby call attention to an accurate preparation for the presented natural phenomena, to which special awareness must be paid during the new NPP's technological construction. At the end of the thesis, I elaborate on the implementation of extreme natural and weather phenomena into the emergency classifications of the CEMAP and the future expanded CEMAP.

SUMMARIZED CONCLUSIONS

Chapter 1: Industrial Safety purpose summary of NPPs' technological and nuclear accident prevention aspects:

a. The first chapter contains a professional knowledge base of educational material with an industrial safety aim related to the establishment and operation of an NPP.
b. From the basic knowledge of NPPs, I reach the relevant professional definitions of Industrial Safety. I present detailed explanations of nuclear technological procedures and legislative environment to give a complex picture of the dangers of using nuclear energy and the possibilities of managing the risk factors.
c. By forming the chapter, I have assumed that by developing an annex with appropriate detail, I can prepare a professional reference material that would accumulate essential knowledge for Disaster Management professionals, relying on which the necessary procedures can clearly be derived in an emergency situation. In light of these, I believe that the present chapter, supplemented with the relevant annexes, is suitable as I have formulated an Industrial Safety Nuclear professional manual.

Chapter 2: Real- time communication and incident response impact factors of existing and planned NPPs:

a. I have formulated the problems that can affect and arise during the operation of the establishment of two immediate neighbouring power plants that are of different generations, have similar principles of operation, but are implemented technologically in a different way.
b. I defined the situations and triggering factors that are the basis of danger, and in correspondence with the principles I have specified in the previous chapter, I explained the importance of real-time communication between the two power plants.
c. In addition to the existing procedures and protocols, I introduced the effective possibility of installing a new system, which could be further increase the safety of the operation of

both NPPs and which would also reach safety areas that overpass the distance between the two nuclear facilities.

d. The aim of the chapter was to further develop management systems in such a way that real-time information is transmitted on event effects and initiated procedures between the responsible organizations of protection. The installation of the OMS that I have outlined to the nuclear safety systems for the two NPPs is a suitable implementation of this hypothesis.

Chapter 3: Development of complex emergency planning for parallel operating NPPs:

a. The chapter deals with the development of emergency management organizations and procedures, for which it first analyzes the protocols of the operating NPP in detail.
b. In the name of nuclear safety, I create a development to expand the CEMAP, FTRP, Industrial Fire Department and APO in a united system for the two parallel operating NPPs.
c. The essence of expanded procedures is to implement such upgrades that will allow the availability of adequate and optimally distributable responding personnel and equipment to deal with emergency situations in the new nuclear facility, which will be built next to the existing NPP.
    - The number of people involved in damage prevention and the development of force and equipment have been upgraded.
    - I have generated an expanded APO structure, which can be applied to power plants individually or in cooperation, depending on the severity of the emergency situation.
    - A combined FTRP design policy and structure has been elaborated.
d. The basic knowledge of the first chapter and the OMS developed in the second chapter can be filed in the procedures of the extended organizations to further enhance the nuclear safety.
e. According to the assumption of my hypothesis, the developed principles in the chapter are able to establish the protection of both NPPs, which is amplified by the usability of the OMS, and overall, it can be declared that the elaborated development directive contributes to nuclear safety to such an extent that not only confirms my hypothesis, but also lays the foundation of the nuclear accident prevention implementation structure that will be used in the future.

Chapter 4: Development of Severe Accident Management procedures by parallel operating NPPs:

a. In the chapter, I first explained the structure of the SAM procedures, the possibilities for their implementation and the security functions covered by the SAM systems.

b. The essence of the SAM development was to expand safety in such a direction that not only one, but both NPPs' safety can be guaranteed in the suggested critical situations.
c. During the emergency situation management, the applicability of the OMS and the importance of possessing the knowledge of nuclear industry safety came up again, by which specialists are able to make decisions about executive measures, based on main knowledge of effects and consequences.
d. In the chapter, I discuss the technological possibilities of parallel and overlapping SAM operation for the two NPP and also define the direction of the necessary developments.
e. Due to the technological diversity, I define a new SAM feeding procedure for the new NPP systems, which was not needed at the existing power plant, because of system deviation.
f. I write proposals for the united SAM system of the two NPPs, regarding the upgrade of equipment and devices, furthermore I deduce how the requirement of increased situation management potential of the expanded SAM supports the need for the development and optimization of the responding team presented in the previous chapter.
g. To create the chapter, I have proven the necessity of the development of my composed hypothesis through the detailed description of the scientific problem to fully cover the targeted security functions.

Chapter 5: Suggestion for augmenting the peripheral protection to parallel operating NPPs:

a. In the chapter, I outline the local parameters of the natural phenomena that may have an impact on the NPP's operation and nuclear safety.
b. I analyze the local attributes of earthquakes, floods and extreme weather conditions with their occurrence probability and the consequences of their effects.
c. In connection to earthquakes, I touch on the implemented safety-enhancing measures and the parameters that are still to be treated as a source of problems in the event of an optional earthquake. I project this onto the requirements for the new nuclear facility.
d. In connection with flood-protection, I present the operation of the group which was set up for flood protection and the areas to be protected. In addition to the built-in and mobile defenses, I formulate a development, and also call attention to critical aspects that must be planned during the construction of the new NPP to implement effective flood protection.
e. I presented two natural and weather-related events to which the development of defense procedures became necessary that the new NPP's safety documentation does not consider sufficiently.
    - In connection with the glaciation incidents, I outline the response steps to the events that took place, which I elaborate with a further development proposal for assimilation

into the combined safety requirements of the two NPPs, so that protection against the forces of nature could be realized together.

- In connection with the extremely low water level, I show that there is a measure in the design of the Paks NPP that can handle the unavailability of the refrigerant, however, I explain what effects this could have on the new NPP and designed a development recommendation for its water supply in such an extreme situation.

f. In relation to the content expansion of the National Report as part of the Targeted Safety Review written in my hypothesis, it can be stated that the two extreme weather events I have presented must definitely expand the regulators, since all of them occurred after the preparation of the Paks II safety documentation and the National Report.

g. The expansion of peripheral protection also complements the CEMAP development, which were described in the previous chapter, since the current emergency management does not count on these. Accordingly, it becomes necessary to implement emergency situations in the new expanded CEMAP classification.

NEW SCIENTIFIC RESULTS

Based on my research work presented in the content chapters of the thesis, I recommend the following new scientific results for acceptance:

1. Based on the investigation of the technological and nuclear accident prevention aspects of NPPs for the purpose of industrial safety, I ***elaborated*** the educational syllabus necessary for the preparation of the intervention staff involved in the management of nuclear incidents, as well as a related Nuclear Emergency Management Manual, which can be used to increase the preparedness of the personnel involved.

2. Built on a comprehensive and comparative analysis of the real-time communication and event response impact factors of existing and planned NPPs, I ***defined*** the technological intervention options for the OMS that take into consideration the construction requirements. In connection with the OMS, I made a specific ***recommendation*** to expand the operational documentation and emergency procedures, as well as for the system's user platform and operating criteria, which ensure the increase of the efficiency of the combined operation.

3. In connection with the nuclear accident prevention tasks of parallel operating NPPs, I have ***determined*** the organizational development possibilities of the APO and the Facility Fire Department, the expansion of the CEMAP and the combined FTRP design criteria system,

with special regard to the implementation of danger alarm levels and the balanced external intervention organizations for its cooperation, which can ensure the conditions of combined operation at a higher level.

4. Based on the analysis of the parallel operating NPPs' SAM procedures, I have ***elaborated*** development proposals for the operation of the Severe Accident Management procedures in a common system in order to unify them, which covers the Severe Accident Management guidelines and the complex procedure concept that takes into account the technological differences of the new NPP, so strengthening the defense preparedness.
5. On the basis of my research carried out for the purpose of expanding the peripheral protection equipment of parallel operating NPPs - concerning earthquake resistance, flood protection and extreme weather situations - ***I included in a scientific system*** the development needs of the safety documentation and the parts of the CEMAP, which promote safe operation conditions.

RECOMMENDATIONS OF THE DISSERTATION

Based on the conclusions and scientific results of my dissertation, I propose the following recommendations for consideration:

1. In connection with the use of all external damage prevention assistance, it should be noted that it is necessary to have adequate knowledge in order to effectively manage the incidents. For this purpose and for the future parallel operation of the two NPPs, I recommend the Nuclear Emergency Management Manual for the professionals of the Disaster Management and Industrial Safety from a knowledge-enhancing or educational point of view, which is an essential help for learning the effective work that is related to individual incidents.
2. In my opinion, the use of the OMS can be a suitable safety auxiliary system for the operation of both NPPs. Due to the real-time transmission of information, it is suitable for implementing faster response measures than the current situation management procedure.
3. The design of the expanded APO, CEMAP, Industrial Fire Department and the combined FTRP expands and develops the operational intervention in both NPPs, so I recommend its use for the NPPs' emergency management, which is accompanied by the organization of the Disaster Management, for whom the development and expansion can be introduced as an efficiency-enhancing procedure.
4. The development of SAM procedures and measures are useful in relation to both NPPs, therefore all the implementation and force-equipment expansion that I formulated can be utilized in connection with the operative implementation of Nuclear Accident Prevention.

5. The concept of peripheral protection is a useful development for the protection of both NPPs. In addition to the leaders and enforcers of security organizations, it also contains essential aspects for the plant personnel and Disaster Management professionals, of which knowledge enables more accurate protection planning and emergency management.

THE PRACTICAL APPLICABILITY OF RESEARCH RESULTS

The practical applicability listed in the new scientific results and recommendations section of the dissertation can basically be interpreted in relation to the currently operating and the new NPP to be established. I used a targeted specific structure and controlled elaboration to cover all aspects of industrial safety, through which I can construct such developments and expansions by which I can align effective solutions for the management of critical and severe incidents. Based on these, in terms of practical usability, I will identify the two NPPs operating in direct vicinity of each other, supplemented by the possibility of expanding knowledge for the specialists of the local and regional members of the Disaster Management. The relevant parts of the conclusions and development recommendations made during the thesis can be applied for any parallel operating NPPs of a different generation or type, despite the fact that its aim is the Hungarian NPP's expansion.

LIST OF PUBLICATIONS PREPARED BY THE PHD CANDIDATE RELATED TO THE TOPIC OF THE THESIS

Book Chapter

[1] Antal Zoltán: A Paksi Atomerőmű árvízvédekezési feladatai. III. Tolna Megyei Polgári Védelmi Munkaműhely „Katasztrófák, kockázatok, önkéntesek" Tanulmánykötet pp. 5-13. 2020

ARTICLES REVIEWED AND SELECTED FROM PROFESSIONAL PERIODICALS (ON-LINE AS WELL)

In periodicals published in foreign language

[2] Antal Zoltán: Basic Risk Assessment of NPPs. Műszaki Katonai Közlöny XXXI. évfolyam, 2021/1. szám, pp95-107. 2021

[3] Antal Zoltán: Severe Accident Management Systems and Procedures. Hadmérnök 16. évfolyam 3. szám, pp41–54. 2021

In periodicals published in Hungarian language

[4] Antal Zoltán, Kátai-Urbán Lajos, Vass Gyula: Atomerőmű létesítés tűzvédelmi követelményeinek vizsgálata. Védelem tudomány II. évfolyam, 1. szám, pp.: 17-30. 2017

[5] Antal Zoltán, Kátai-Urbán Lajos, Vass Gyula: Atomerőművek létesítést megelőző alapvető szabályozóinak és tervezési kritériumainak vizsgálata. Bolyai Szemle XXVI. évfolyam, 1. szám, pp.: 126-139. 2017

[6] Antal Zoltán, Kátai-Urbán Lajos, Vass Gyula: Atomerőmű generációk fejlődésének vonzatai. HADMÉRNÖK XIII. 3. pp 150-163. 2018

[7] Antal Zoltán, Kátai-Urbán Lajos, Vass Gyula: Nukleáris biztonsági irányelvek magyarországi megvalósulása. Védelem Tudomány: Katasztrófavédelmi Online Folyóirat (2498-6194): IV. 2. pp 122-145. 2019

[8] Antal Zoltán, Révai Róbert, Bérczi László: Nukleáris baleset-elhárítás Magyarországon, különös tekintettel az egészségügyi hatásokra – I. rész. Műszaki Katonai Közlöny XXIX. évfolyam, 2019/3. szám, pp5-20. 2019

[9] Antal Zoltán, Révai Róbert, Bérczi László: Nukleáris baleset-elhárítás Magyarországon, különös tekintettel az egészségügyi hatásokra – II. rész. Műszaki Katonai Közlöny XXIX. évfolyam, 2019/4. szám, pp135-155. 2019

PRESENTATION PUBLISHED IN AN INTERNATIONAL PROFESSIONAL CONFERENCE DOCUMENT (ON-LINE AS WELL)

Articles reviewed and selected from professional periodicals and written in Hungarian language

[10] Antal Zoltán: A Paksi Atomerőmű Súlyos Baleset Kezelési eljárása keretében alkalmazott külső hűtőközeg-betáplálás. KONFERENCIA KIADVÁNY „Iparbiztonsági és Hatósági Szakmai Nap” Tudományos Konferencia pp. 8-15. 2020

Abstract/poster in Hungarian language

[11] Antal Zoltán: Atomerőmű létesítés Katasztrófavédelmi követelményeinek kutatása és fejlesztése című poszter. KONFERENCIA KIADVÁNY, „Veszélyes tevékenységek biztonsága” Nemzetközi Iparbiztonsági Tudományos Konferencia pp. 315. 2018

THE DOCTORAL CANDIDATE'S PROFESSIONAL AND ACADEMIC BIOGRAPHY

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Place and date of birth: Pápa, 29 April, 1985.

Studies:

In 2009, he obtained a Diploma in Communicator specializing in electronic media at the János Vitéz Faculty of Pázmány Péter Catholic University. He began his Defense Administration studies at the Miklós Zrínyi National Defense University in 2011. In 2014, he obtained a degree certificate as a Defense Administrator Officer at the institution that was reorganized into the University of Public Service in the meantime. In 2017, he obtained a master's degree at the University of Public Service as a certified Defense Administrator Manager. He started his PhD studies at the Doctoral School of Military Engineering in 2017.

Professional career:

He started his career as a firefighter in 2008 at the industrial fire department of ISD Dunaferr Ltd., where, from 2014, he performed the activities of assigned manager and fire chief. In 2015, he was admitted to the MVM Paks NPP Ltd, Atomix Ltd. Industrial Fire Brigade, as an Assistant Crew Commander and alpine rescue leader, and since 2018 he has been serving as deputy duty commander and radiation protection officer. In 2022, in addition, he also obtained a paramedic qualification, with which he also performs specialized tasks at the Fire Department of the NPP.

Scientific activity:

He has more than 14 years of experience as a firefighter in the field of industrial safety, firefighting and technical rescue. He has been working at the NPP for 7 years and is actively involved in nuclear accident prevention. In connection with the NPP, the Doctoral School of Military Engineering and the fire department, he arrived at the candidate's main field of research, which, based on his professional background, became nuclear emergency management. He carried out industrial safety, radiation protection, health and special rescue studies for his research field, which he detailed in his thesis and in the related publications. He participated in several domestic and international conferences, exhibitions and competitions.

Budapest, 20 September, 2022.

Zoltán Antal-Farkas