

NUCLEAR SECURITY AND NUCLEAR SAFETY: DEFINITION, LEGAL ASPECTS AND HOLISTIC APPROACH TO THE CONCEPTS*

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The subject of this paper is scientific description of the terms nuclear security and nuclear safety, with reference to international legal aspects and necessary holistic approach to these concepts. Taking into account that there are overlapping and inconsistent use of the abovementioned terms in both domestic and foreign literature, the aim of this paper is to describe them precisely, point to the main differences and similarities in terminology, in order to enable their understanding, adequate use in scientific and professional literature, as well as holistic approach in practice. The connection between the terms stems from their common goal – protection of people and the environment from harmful influence of radioactivity, whereas the terms diverge in areas where the requirements for achieving nuclear security and nuclear safety are in complete contradiction. Nuclear security refers to the protection of nuclear materials and facilities from unauthorized access, theft and abuse, with primary focus being on preventing criminal activities. Nuclear safety, on the other hand, has an aim to prevent accidents in nuclear facilities, as well as to protect people and the environment from potentially harmful influence of radioactivity. Holistic approach requires integration of nuclear security and safety measures, in order to achieve synergy between the two concepts, and, at the same time, make sure that their implementation does not jeopardize one another. This way, societies and states can reduce risks to nuclear materials and facilities, both from unauthorized access and potential hazards arising from nuclear processes and facilities.

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Introduction

Nuclear security and nuclear safety are two key concepts which are often used in scientific and professional literature, international relations, security and defence strategies, legal acts of certain states, as well as other documents. Even though these terms are often incorrectly used as synonyms, it is important to emphasize that they have different meanings and application methods. Nuclear security is focused on preventing unauthorized access, theft and abuse of nuclear materials and facilities in which they are used, while nuclear safety refers to prevention of accidents in nuclear facilities, as well as protection of people and the environment from harmful effects of radioactivity. For the purpose of making a clear distinction between the two terms, and precise understanding of the terms, as well as the application of these terms in practice, the aim of this paper is to describe nuclear security and nuclear safety, and point to the similarities and differences in their terminology. Nuclear security and nuclear safety should be designed and implemented in an integrated manner, so that the implementation of security measures does not jeopardize safety, and vice versa. This holistic approach is necessary in order to maximize the synergy between both concepts and to achieve optimum level of protection.

The application of nuclear weapons, sabotage, or diversion at nuclear facilities, nuclear accidents and use of “dirty bomb” are serious threats which require international cooperation in the field of nuclear security and safety. These threats do not obey state borders, therefore adequate cooperation and understanding among states is of the utmost importance. Such cooperation implies acting on the level of international agreements, correct and timely exchange of information and technologies, planning and implementing joint trainings of personnel and people in charge of protection and planning responses to different scenarios of nuclear accidents or terrorist attacks. Speaking of the latter, three main possibilities of terrorist attacks, using nuclear and radiological weapons, can be singled out (Indić & Filipović, 2018): application of nuclear weapons (fission), when terrorists would use authentic nuclear weapons (the probability of such scenarios is extremely low, but it poses great danger both for human lives and the environment); sabotage or diversion at a nuclear facility, when terrorist would infiltrate into nuclear-energetic facilities or research reactors; use of weapons for radiological dispersion (“dirty bomb”) which includes use of radioactive materials along with typical explosive device for the purpose of its dispersion, and with the aim of causing panic and pollution. “Dirty bomb” poses a serious threat, because it does not necessarily contain highly refined radioactive material used in nuclear bombs. Instead, one can use radioactive material found in hospitals, nuclear power plants or research laboratories, making the production of this type of weapon much cheaper and faster compared to nuclear weapons.

The International Atomic Energy Agency (IAEA) defines both concepts in their documents and publications and their standards play an important role in harmonization with international agreements and norms. Taking into account the legal context of the Republic of Serbia, the paper also emphasizes the importance of harmonizing national legal regulations with international standards in these areas.

Defining nuclear security and nuclear safety

Nuclear security and nuclear safety are two key concepts used in the context of application of nuclear technologies, management of nuclear materials, nuclear facilities and different aspects of nuclear activities. Likewise, these terms have a role in communication in reference to control and prevention of nuclear weapons proliferation (one of the greatest security threats in modern world, Stefanović, 2020), for the purpose of ensuring that nuclear technology and accompanying resources will be used for peacetime purposes and under controlled conditions. In some languages, there is only one term for both concepts, while in other languages which have two different terms, these terms are often used incorrectly and inconsistently. For example, in languages such as Uzbek and Hindi, the same word is used in both cases (Hirst, 2020). This can cause confusion and difficulty in understanding in international discussions, especially when it comes to nuclear security and prevention of spreading nuclear weapons and other weapons of mass destruction and creating nuclear safety measures. Therefore, it is important to understand the differences between them and to use correct terms in accordance with their meaning. When it comes to European countries, separate terms are used for both concepts, in the majority of cases. For example, in French, Italian and Spanish languages there is a clear distinction between these terms (Homanetal., 2022). In addition, in Serbian language there are two separate terms, but in official terminology in many areas, the notions of “safety” and “security” are often used as synonyms, alternately and in different connotations (e.g. security at work, food safety, social security, the Security Information Agency, etc.). In the field of radiation and nuclear safety and security in Serbia, which is primarily regulated by the Law on radiation and nuclear safety and security (*“The Official Gazette of the Republic of Serbia”*, No. 95/18 and 10/19), the terms safety and security are separated and clearly defined in accordance with international standards and recommendations in this field. Namely, the concepts of nuclear security and safety are established and defined in individual security standards and guides for nuclear security of the International Atomic Energy Agency.

Nuclear security under the auspices of the IAEA

Defining nuclear security can encompass measures and actions applied for the purpose of preventing unauthorized access to nuclear materials, facilities and technologies, as well as prevention of malicious use of nuclear materials and technologies for harmful purposes. According to the IAEA documents, nuclear security is defined as prevention, detection and response to theft, sabotage, unauthorized access, illegal transfer or other malicious acts involving nuclear material, other radioactive materials or facilities in reference to them (IAEA, 2004, 2013, 2019, 2020a, 2020b, 2022). The concepts of nuclear security are described by the IAEA in its thematic publications, in accordance with international legal instruments of nuclear security, and amended, such as the Convention on the Physical Protection of Nuclear Material and its amendments, the Code of Conduct on Safety and Security of Radioactive Resources, the United Nations Security Council Resolution 1373 and 1540, and the International Convention on Suppression of Acts of Nuclear Terrorism. The publication from the field of nuclear security (*nuclear security series*) are being published in the following categories: basics of nuclear security which contain goals, concepts and principles of nuclear security and provide the basis for security recommendations; recommendations which are proven to be the best practices which can be adopted by the member states when applying the basics of nuclear security; implementation guides which provide further development of recommendations in wider fields and suggest measures for their implementation. The publications of technical instructions comprise: relevant manuals with detailed measures and/or instructions on how to apply the implementation guides in certain areas or activities; training guides which cover the curriculum and/or manuals for the IAEA training courses in the field of nuclear security and service guides, which provide guidelines on management and scope of the IAEA advisory missions for nuclear security.

Therefore, nuclear security refers to the measures taken in order to prevent unauthorized access, thefts, sabotages and other malicious acts involving nuclear and other radioactive materials or facilities. That includes physical-technical protection, cyber security, personnel reliability (prevention of insider threats) and other measures for prevention of unauthorized access and ensuring security of nuclear and other radioactive material, in all stages of its use, storage or during transportation, and other connected activities, as well as the security of the facilities where the material is stored and used.

International legal framework for nuclear security and nuclear safety

Besides standards and recommendations by the IAEA, within international frameworks there is a large number of legal documents which regulate the fields of nuclear safety and security, and where the distinction is being made between these two concepts. A wide range of topics is being regulated by international conventions and

legal agreements, starting from nuclear security, nuclear safety, protection measures and non-proliferation of nuclear materials, as well as civic responsibility for nuclear damage.

International documents which regulate the issues of nuclear security, prevention of acts of terrorism, as well as spreading of the weapons of mass destruction are as follows:

- The Convention on the Physical Protection of Nuclear Material, CPPNM. The CPPNM was adopted on 26th October 1979 and came into force on 8th February 1987 (amended in May 2016). Nowadays it is a main international legally binding document in the field of physical protection of nuclear materials and nuclear facilities used for peacetime purposes. The Convention was additionally amended and it is relevant for all the signatory states, not only for those which possess nuclear facilities or active nuclear programmes.
- The Convention Amendments from 2005 broaden the scope of the original agreement onto physical protection of nuclear facilities and nuclear materials which are used for peacetime purposes in domestic use, storage and transportation. Also, it additionally criminalizes criminal acts regarding illegal trade and sabotage of nuclear materials or nuclear facilities, and it stipulates strengthening and widening the scope of international cooperation, such as assistance and exchange of information in case of sabotage. The Convention Amendments are of the utmost importance for nuclear security globally speaking, and have huge influence on reducing the vulnerability of the signatory states from nuclear terrorism.
- Primary legal instruments under the auspices of the United Nations:
- The International Convention for the Suppression of Terrorist Bombings from 1997 and the International Convention for the Suppression of Acts of Nuclear Terrorism.
- The International Convention for the Suppression of Acts of Nuclear Terrorism came into force on 7th July 2007 and it is an international criminal law instrument defining certain acts as criminal acts, it binds the signatory states to establish their jurisdiction for such criminal acts and make them punishable in accordance with their domestic legislations. The abovementioned Convention also stipulates the introduction of extradition or prosecution of suspected criminals in accordance with the principle *aut dedere aut judicare* (Latin for “either extradite or prosecute”), which refers to legal obligation of states, in accordance with international public law, to prosecute the persons who committed serious international crimes when no other state has requested extradition.
- The UN Security Council Resolutions, adopted in accordance with Chapter VII of the Charter of the United Nations: The UN Security Council Resolution 1373 from 2001 and the UN Security Council Resolution 1540 from 2004. The UN Security Council Resolution 1373, adopted unanimously on 28th September 2001 as counter-terrorism measure, was adopted after the terrorist attack on the USA on 11th September 2001. After the UN Security Council debate on the weapons of mass destruction on 22nd April 2004, and in order to once again confirm unequivocal condemnation of the attack, and establish wide, comprehensive steps and strategies and establish comprehensive regime of the war

on terror, the UN Security Council Resolution 1540 was adopted unanimously on 28th April 2004, which stipulates that all the countries shall not support any non-state actors trying to procure, use or transport nuclear, chemical or biological weapons and their delivery systems. The UN Security Council Resolution 1373 (2001) and the UN Security Council Resolution 1540 (2004) were adopted in accordance with the Chapter VII of the Charter of the United Nations and therefore are binding for all states.

- Legally non-binding instruments under the auspices of the IAEA:

Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5); The Code of Conduct on the Safety and Security of Radioactive Sources and the Guidance on the Import and Export of Radioactive Sources. The abovementioned legally non-binding instruments under the auspices of the IAEA are significant guidelines and codes which influence raising of the standards in the field of nuclear security and safety.

Legally non-binding instruments under the auspices of the UN:

- The United Nations Global Counter-Terrorism Strategy (A/RES/60/288). This is a comprehensive strategy for the war on terror aiming at strengthening states' capacities and the role of the UN system for preventing terrorism and the war on terror, simultaneously promoting human rights, as well as the rule of law.
- The Treaty on the Non-Proliferation of Nuclear Weapons is an international agreement with the aim to prevent further spread of nuclear weapons and to stimulate disarmament. The Treaty is crucial legal framework in the field of nuclear security and non-proliferation. The Treaty was adopted in 1968, and so far it has been ratified by 191 state, including Serbia. The Treaty on the Non-Proliferation of Nuclear Weapons laid the basis for the IAEA to create and implement the system of safeguards which is a set of measures used to control nuclear material and its application in the signatory states. By signing the Agreement on Safeguards, as well as the Additional protocol accompanying the Agreement, the signatory states are obliged to keep records on nuclear material, as well as non-nuclear material and accompanying activities connected to nuclear fuel cycle. In addition, they are obliged to submit the records to the IAEA, which, on the other hand, reserves the right over inspection supervision over the states' nuclear programmes and accompanying activities which include the application of nuclear weapons for peacetime purposes.
- These legal instruments and conventions have the aim to promote international cooperation in the field of nuclear security, as well as in application of nuclear technologies in general and establishing common framework for understanding and risk prevention connected to nuclear materials and facilities. Also, they provide legal platform which obliges the signatory states to harmonize their standards and make joint efforts to prevent nuclear terrorism and ensure secure and safe use of nuclear technologies.

International documents and conventions regulating the issues of nuclear safety are as follows:

- The International Convention on Nuclear Safety obliges the signatory states which manage civilian nuclear programme to maintain high level of safety by establishing basic safety principles.
- The Convention on Early Notification of a Nuclear Accident – The Early Notification Convention, and the The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency – The Assistance Convention. The Early Notification Convention and the Assistance Convention were adopted right after the Chernobyl disaster in 1986. The aim of these Conventions is to ensure a mechanism for exchange of information on nuclear accidents as soon as possible for the purpose of minimizing their over-limit radiological repercussions.
- The IAEA Safety Standards are a set of guidelines and requirements developed by the IAEA in order to assist the member states to establish effective measures of nuclear and radiation safety.
- The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management established safety standards for the management of spent fuel and radioactive waste.

The abovementioned legal instruments and Conventions have the aim to establish common understanding of the risks regarding the application of nuclear technologies and radioactive materials for peacetime purposes, as well as to ensure that the abovementioned activities are implemented safely and responsibly.

Nuclear safety and security in Serbia

The activities related to use of nuclear and radioactive materials in the Republic of Serbia are regulated by an umbrella legal act the Law on Radiation and Nuclear Safety and Security (*“Official Gazette of the Republic of Serbia”*, No. 95/18 and 10/19), as well as accompanying by-laws. The Republic of Serbia is also a signatory to all international agreements and conventions (listed in the previous part of the paper) in the field of safety and security, whose provisions were transferred into domestic legislature or the conventions themselves were fully adopted as legally binding acts. Also, the field of radiation and nuclear safety and security has been completely harmonized with the IAEA standards and recommendations. By implementing the concept of clear distinction between the terms safety and security in this field, established and adopted by the IAEA, but also by other international organizations, these terms are defined in the same manner in domestic legislature, as well as in practical application when carrying out radiation and nuclear activities.

The Law on Radiation and Nuclear Safety and Security defines radiation and nuclear safety as a set of measures taken for the purpose of meeting certain conditions for carrying out radiation and nuclear activities, preventing the occurrence of an emer-

gency and diminishing its consequences for the purpose of protection of the workers, the population and the environment from harmful influence of ionizing radiation. Radiation and nuclear safety imply a set of prescribed organizational and technical-technological measures which ensure optimum planned exposure and optimum risk of possible exposure to ionizing radiation due to the use of radiation source, also including radiation protection measures, measures for preventing emergencies and measures for diminishing consequences of an emergency if one occurs. Radiation and nuclear security comprises measures for prevention, detection and response to cases of theft, sabotage, unauthorized access, illegal transportation, abuse or other criminal acts involving nuclear or radioactive materials, as well as connected facilities and activities. Also, the legislature framework, in all its provisions which regulate the field of nuclear and radioactive materials application, places the emphasis on integrated application of both safety as well as security measures in practice.

Holistic approach to the concepts

Holistic approach to nuclear security and safety implies taking into account all the aspects of application of safety and security measures in an integrated and comprehensive manner, for the purpose of adequate use of nuclear and other radioactive materials, as well as the protection of the mentioned materials and the facilities in which they are used, as well as the connected activities. This is a comprehensive approach which recognizes that the measures of nuclear security and nuclear safety are unbreakably interconnected and that they must be observed, applied and solved together, in order to create an efficient nuclear and radiological risks management system. Operators have a task to integrate security-safety interface into basic operational work. Security and safety measures must be implemented in the operation of a certain facility during its every phase – starting from designing and construction, exploitation, to decommissioning and dismantling (Gandhi & Kang, 2013). Taking into account that nuclear security refers to the measures taken in order to prevent unauthorized access, theft, sabotage, or other malicious acts involving nuclear materials or facilities, whereas nuclear safety, on the other hand, refers to the measures taken for the purpose of preventing accidents or incidents which could lead to uncontrolled spread of radioactivity, therefore holistic approach, in this respect, should imply integration of these two aspects of radiological risks management into one comprehensive framework dealing with all potential threats and risks. Therefore, while designing a security system it is important to take into account both safety measures implemented during the facility designing phase, protection from radiation during regular operation, preparedness for emergency situations and other measures ensuring safe facility operation, as well as the measures of physical-technical protection of nuclear facilities and materials, insider and cyber threats, and other measures for preventing unauthorized access and unauthorized activities.

Many authors clearly emphasize that there should be a synergy between nuclear security and safety, and that integrated approach between these concepts should be

adopted (Gandhi & Kang, 2013; Sandersetal., 2015; Suzuki, 2018; Vasmant, 2009; Zakariya & Kahn, 2015). Terrorists, whose aim is sabotage of nuclear facilities and uncontrolled radiation release, cannot easily get access to information on nuclear facilities security systems, including the information on vital systems of the facility itself such as power sources or cooling systems. Such information is not easy to obtain, but well prepared terrorists, especially those who can establish connections with people who work within nuclear facilities, would probably succeed in doing so (Kim & Kang, 2012).

According to the IAEA, nuclear security measures and nuclear safety measures should be prescribed and implemented in an integrated manner in order to develop synergy between these two fields, but also in a way that security measures do not jeopardize safety, and that safety measures do not jeopardize security (IAEA, 2022). In that regard, measures of security and safety culture which are prescribed, adopted and obeyed in all relevant organizations also have an important role. Actually, it can be said that only the organization where security and safety culture are in harmony is able to identify obstacles for security and safety improvement, and to create more efficient interaction between these two domains (Khripunov, 2023).

In the past, it was considered that security systems can interfere with safety practices and vice versa. For example, when speaking about nuclear security measures, it is necessary to prevent access to nuclear material and all the information referring to its protection systems. On the other hand, when it comes to nuclear safety, it is necessary to post warning signs, such as radiation hazard signs or signs warning about increased radioactivity levels due to the presence of nuclear or other radioactive material, as well as to provide free evacuation routes without strong bars or barriers, which are an indispensable element of physical protection system in the field of nuclear security. From that point of view, it can be concluded that apparently these are two completely different (even opposing) concepts. Nevertheless, nuclear security as well as nuclear safety, have the aim to protect people and the environment from being endangered due to exposure to radioactive radiation. Therefore, they share the common end goal and certain characteristics, but general approaches and specific security and safety measures are different. It is important to mention that safety standards and nuclear security guidelines have developed separately until recently, starting from different bases, and they were published in different IAEA documents. Thus, there was a possibility for confusion in the use of specific terminology, especially in reference to the terms used in the publications dealing with connected aspects of safety and security (IAEA, 2022).

Besides, holistic approach should include organizational, legal and regulatory measures in order to ensure that nuclear and other radioactive materials, as well as accompanying facilities, are used safely and securely. Also, the engagement of all the interested parties is very important, as well as to build public trust into the system of nuclear and radiation safety and security, both in the country and on international level. This requires transparency and openness in communication, as well as active inclusion of local communities and other interested parties in the process of making decisions referring to nuclear and radiation security and safety.

Conclusion

Taking into account the significance of application of nuclear technologies for the world community, precise definition and understanding of the terms nuclear security and safety is a key aspect of the utmost importance in achieving proper communication and adequate approach to these fields. Even though there are linguistic differences and confusion in the use of these terms in different languages, it is the most important to emphasize their mutual connection and the significance of holistic approach. Nuclear security and nuclear safety together make up the essence of efforts for controlled application of nuclear materials and technologies, and must be considered and applied in a comprehensive protection system. Besides, nuclear and radiation security and safety share a common universal goal which refers to protection of individuals, population, property and the environment from harmful influence of radioactive radiation. Nevertheless, there are certain areas between them where requirements for meeting a satisfying level of security and safety can be contradictory. Therefore, in order to achieve synergy between nuclear safety and nuclear security it is necessary to identify the contradictory requirements. It should be established whether it is the field of culture, the way of reacting in emergency situations, control of access and transportation of nuclear materials, etc. Solving of such potential conflicts between nuclear security and nuclear safety should be observed through a prism of minimizing overall risk to people and the environment. Therefore, it is important that both concepts are observed as two connected subjects which mutually strengthen and integrate each other. Security measures, as well as safety measures, should be designed and implemented in an integrated manner so that their implementation protects the wellbeing of people and the environment. Therefore, holistic approach to nuclear security and safety is of the utmost importance for ensuring secure and safe use of nuclear technologies and preventing accidents and other hazards, regardless whether they are the consequence of technical-technological processes, human errors or malicious acts. Such approach is of the utmost importance for safe management of nuclear material and technology, because different aspects of security and safety are overlapping and must be addressed as a whole, not only separately.

Thus, considering all the aspects presented in the paper, it can be concluded that holistic approach to these concepts is a key for achieving optimum level of protection of both people and the environment from potential radiological risks.

It is important that the Republic of Serbia continues to harmonize national legal regulations with international standards in the field of nuclear security and safety, and to continue to improve them constantly. This is the only way for the national system of nuclear and radioactive risks management to be coordinated with the highest international standards.

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Summary

The subject of this paper refers to scientific description of the terms nuclear security and nuclear safety, with the emphasis on achieving the necessary holistic approach to these concepts in practice. There is confusion and inconsistent use of the previously mentioned terms both in domestic and foreign literature, thus the aim of this paper is to precisely describe them and point to the similarities and differences in terminology.

In addition, the aim is to enable correct understanding and use of these terms in scientific and professional context, and the application of holistic approach in practice. The main aim of both concepts is protection of people and the environment from radioactive hazards, but the difference between them lies in the ways this goal is achieved. The key is to design and implement security and safety measures in an integrated way so that they do not jeopardize each other.

Nuclear security and nuclear safety are two concepts which are often used together, but they have different meanings and applications. Nuclear security refers to the measures and practices applied for the purpose of preventing unauthorized access to nuclear materials, facilities and technologies, as well as preventing abuse of nuclear materials or facilities for harmful purposes, while nuclear safety refers to the measures taken in order to ensure safe operation of nuclear facilities and prevent accidents or incidents.

The IAEA defines the concepts of nuclear security and safety in its documents and publications. The IAEA documents describe the concepts of nuclear security as prevention, detection and response to theft, sabotage, unauthorized access or illegal transportation of nuclear materials or facilities referring to them. The difference between these two concepts comes from different requirements and priorities set up for the purpose of achieving nuclear security and nuclear safety.

The importance of holistic approach for these concepts implies that the measures for their implementation must be observed, applied and solved together in order to create efficient nuclear and radiological risks management system. Holistic approach implies that these concepts are inter-connected and that they must be observed within a comprehensive system.

Key words: *nuclear security, nuclear safety, nuclear law, terrorism, security*

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