*Environment. Technology. Resources. Rezekne, Latvia*
*Proceedings of the 16th International Scientific and Practical Conference. 2025. Volume V, 81-87*

# *Radioactive Waste Storage as an Element of National Security*

**Nikolay Todorov Dolchinkov**
*Vasil Levski National Military University, Veliko Tarnovo, Bulgaria*
Veliko Tarnovo, Bulgaria
n_dolchinkov@abv.bg

**Nikolay Iliyanov Padarev**
*Vasil Levski National Military University, Veliko Tarnovo, Bulgaria*
Veliko Tarnovo, Bulgaria
nikolai_padarev@abv.bg

***Abstract*— The presence of numerous nuclear power plants on the European continent is a guarantee of the energy security of the countries of the continent. At the same time, the problem of storing spent nuclear fuel is also deepening, because fewer and fewer manufacturers are engaged in its processing. The use of radioactive isotopes in medical diagnostics and treatment is also increasing, as well as in many sectors of the economy. But for now, the problem of storing these radioactive materials is lagging. The prospects for storing these materials have been examined and based on the data on the presence of radioactive waste, a systematic proposal for short-term and long-term storage of these materials has been made. The study is in its initial phase and the values are yet to be specified and a more precise proposal for storing nuclear waste is to be made.**

***Keywords*— medical diagnostics, medical treatment, national security, nuclear fuel, nuclear power plant, pollution, radioactive waste repository, radioactive isotope, storage.***

## I. Introduction

Nuclear waste storage is an important and complex issue related to the safety and sustainability of nuclear energy. Radioactive waste requires special storage conditions, as it remains hazardous to the environment and human health for thousands of years [1], [2].

One approach is the construction of deep geological repositories, which are located hundreds of meters below the earth's surface. In them, the waste is stored in special containers that are resistant to corrosion and mechanical damage. In Bulgaria, the construction of such a repository is planned by 2050, but a specific location has not yet been selected.

This process requires careful planning and public consent, as people often express concerns about the safety of such facilities [3], [4].

Nuclear waste is material that remains radioactive and hazardous after its use in nuclear technologies. It is usually classified into three categories:

1. Low-level waste - includes contaminated instruments, clothing and filters, which have relatively low levels of radiation.

2. Intermediate-level waste - usually includes materials from structures and equipment that have been exposed to radiation.

3. High-level waste – the most dangerous form, containing spent nuclear fuel and residues from nuclear reactions [5].

Who generates nuclear waste?

NPP (nuclear power plants): the main source of nuclear waste from electricity generation.

1. Medical industry: when using radioactive isotopes for diagnosis and treatment.

2. Scientific research: in laboratories working with radioactive substances.

3. Industry: when using radioactive materials for certain technological processes, such as quality control.

4. Military industry: in the production and maintenance of nuclear weapons.

Nuclear waste poses a major challenge for storage and management due to its long radioactivity period.

## II. Materials and methods

Nuclear waste management involves various approaches aimed at safe storage, reducing radiation hazards, and minimizing long-term risks [6], [7]. Here are the main methods:

*Online ISSN 2256-070X*
*https://doi.org/10.17770/etr2025vol5.8502*

Interim storage: The waste is initially stored in specially designed containers, usually on the site of the nuclear power plant. This is an interim step until a decision is made on long-term storage.

Long-term storage in geological repositories: Radioactive materials are isolated at great depth in stable geological formations [8]. This is considered one of the safest methods because it minimizes the impact on the environment and people.

Recycling and reuse: Spent nuclear fuel can be reprocessed to extract valuable materials, such as uranium and plutonium. This process reduces the amount of high-level waste.

Stabilization and encapsulation: The waste is treated chemically or physically to make it more stable before being encapsulated in durable containers.

Transmutation: An advanced method in which radioactive isotopes are converted into less radioactive ones through nuclear reactions. It is still under development and is not widely available.

Dry storage: Used for spent fuel that is cooled in special containers made of metal and concrete.

These methods are combined with strict regulations and monitoring to ensure maximum safety.

International standards for nuclear waste management have been established to ensure the safety of people and the environment. They include principles, guidelines, and regulations that are applied in different countries. Here are some key aspects:

- International Atomic Energy Agency (IAEA): The IAEA provides guidelines and standards for the safe management of radioactive waste, including storage, transportation, and disposal. A key document is the "Basic Principles for Radioactive Waste Management," which emphasizes the importance of long-term safety.
- European standards: Within the European Union, Directive 2011/70/Euratom establishes a framework for the responsible and safe management of spent fuel and radioactive waste. This directive requires Member States to develop national waste management programmes and ensure transparency.
- International conventions: The Convention on the Safety of Spent Fuel and Radioactive Waste Management is a key international treaty that promotes cooperation between States. The Convention on the Physical Protection of Nuclear Material also plays an important role in preventing unlawful access and use.
- National programmes: Each State is responsible for developing national programmes that meet international standards and take into account the specific conditions of the State [9], [10].

Improper storage of nuclear waste can have serious consequences for both the environment and human health. Here are some of the main risks:

- Environmental contamination: Radioactive substances can enter the soil, water sources and the atmosphere. This contamination can have long-term effects on ecosystems, destroying local flora and fauna.
- Human health hazards: Exposure to radiation can cause serious illnesses, including cancer, mutations and damage to the reproductive system. Even low levels of radiation can have a cumulative effect on human health.
- Accidents and incidents: Improper storage can lead to explosions, leaks or fires that can spread radioactivity over a wide radius. For example, the Chernobyl and Fukushima incidents have shown the catastrophic potential of such situations.
- Economic consequences: Contamination by radioactive waste can require enormous resources for clean-up and restoration. Affected regions often experience economic losses, such as loss of tourism and productivity.
- Social and political tensions: People living near poorly managed facilities may be forced to evacuate or suffer social stress. Such cases often trigger public protests and international criticism [1], [11], [12].

Proper management and storage are critical to minimizing these risks. The long-term effects of improper storage of nuclear waste can be catastrophic for nature, human health, and socio-economic development. Here is what can happen:

1. Persistent contamination of soil and water: Radioactive materials can leach into soil and water sources, causing contamination for hundreds or even thousands of years. This makes these resources unfit for use by humans, animals, and plants.

2. Genetic mutations and diseases: Long-term radiation can lead to genetic changes and serious health problems for generations to come. Common consequences include cancer, infertility, and hereditary diseases.

3. Destruction of ecosystems: Radioactivity can destroy biodiversity by killing plant and animal species or altering their natural habitat.

4. Economic and social challenges: The affected areas often remain uninhabited, leading to depopulation and loss of economic potential. Evacuation of the population and long-term clean-up require enormous resources.

5. Destabilization of public trust: Such situations can cause distrust in institutions and public tension.

Historical examples, such as the Chernobyl accident, show how improper management of radioactive substances can leave lasting scars on humanity and the planet. Proper planning and strict regulations are key to preventing these dangers [13].

The short-term effects of improper storage of radioactive waste can be presented as:

1. Environmental contamination: Radioactive leaks can quickly spread into the soil, air and water, causing harm to local ecosystems.

2. Danger to humans and animals: Radiation emissions can expose humans and animals to radiation, leading to acute health problems such as radiation burns or poisoning.

3. Fires and explosions: Under unsafe conditions, radioactive materials can be a factor in accidents such as fires or explosions, which significantly increase the risk.

4. Social tensions: Lack of trust and panic can arise among the local population, especially if the problems are not well communicated [14].

Measures for proper storage of radioactive waste:

1. Use of specialized containers: Storage in resistant containers that protect against corrosion, leakage and mechanical damage.

2. Controlled repositories: Temporary storage in secure facilities that are well isolated and under strict monitoring.

3. Geological repositories: Long-term storage in stable geological formations where the waste is physically isolated.

4. Regular monitoring and inspections: Systematic monitoring and maintenance of facilities to prevent accidents.

5. Reprocessing and recycling: Reusing spent nuclear fuel to reduce the amount of radioactive waste.

6. Public awareness: Transparency in communication with the public to reduce fear and ensure support for projects.

These measures are critical to preventing the risks associated with radioactive waste [15], [16].

## III. Results and discussion

Detecting improperly stored radioactive waste requires a combination of classical methods and modern technologies. Here are some of the traditional approaches and potential innovations in this field:

Classical methods

1. Geiger-Muller counter: One of the most well-known instruments for detecting radiation. It measures beta and gamma radiation and is used to scan suspicious locations.

2. Scintillation detectors: Used to measure radiation emissions by analysing the light emitted when radiation interacts with certain materials.

3. Soil and water sampling: Laboratory analysis of samples from contaminated areas can detect the presence of radioactive substances.

4. Handheld detectors: Portable devices that are used to inspect small areas or containers.

Modern and innovative methods

1. Drones with radiation sensors: Drones equipped with radiation detectors can scan large areas that are otherwise difficult for humans to access.

2. Spectroscopy: Advanced analysis that identifies specific radioactive isotopes by measuring the energy of their emission.

3. Satellite monitoring: Satellites with radiation sensors can locate areas of increased radiation over a large area.

4. Thermal infrared technology: Useful for detecting temperature anomalies that may indicate improperly stored radioactive waste.

5. Autonomous robots: Robots that can operate in hazardous areas and collect data without risk to humans.

6. Biological indicators: Monitoring changes in vegetation, animals, or microbes in areas can provide an indication of radioactive contamination.

The integration of classical and modern methods increases the effectiveness of hazard localization.

Preventive measures

1. Monitoring of risk areas: Continuous monitoring of areas with known nuclear activity.

2. Public awareness: Training the local population to recognize suspicious materials.

3. Regulatory inspections: Regular inspections of industrial and medical facilities.

These methods, combined with adequate training and technology, significantly assist in the detection and management of accidental radioactive waste [17].

High-level radioactive waste is stored using specialized methods that ensure safety and minimize risks to the environment and people. Here is how it is stored:

Nuclear waste storage methods can be categorized into the following types:

- Cooling pools: Spent nuclear fuel is initially stored in water pools that cool the fuel and provide radiation protection.
- Dry storage: After cooling, the fuel is transferred to special containers made of durable materials such as concrete and metal.
- Geological repositories: Long-term storage in stable geological formations that isolate radioactive materials from the environment.

In Bulgaria, spent nuclear fuel from the Kozloduy NPP is stored in specially constructed facilities. There is a dry storage facility on the plant site that ensures safety through the use of durable containers. In the past, the fuel was returned to Russia for reprocessing, but now solutions are being sought for long-term storage in the country [18].

The government is considering the possibility of building a geological repository for long-term storage, but choosing a suitable location and public acceptance remain challenges [4].

In Bulgaria, the management of spent nuclear fuel (SNF) and high-level radioactive waste is a complex process that involves several stages and strategies for long-term storage. Here is more detailed information:

Current status of storage in Bulgaria

1. Interim storage:

Spent nuclear fuel from Kozloduy NPP is initially stored in near-reactor cooling pools. This is a standard practice that ensures safety and reduces the temperature of the fuel.

After cooling, the fuel is transferred to specially constructed dry storage facilities. In Bulgaria, CONSTOR 440 containers are used, which are resistant to corrosion and mechanical damage.

2. Long-term plans:

Bulgaria has the capacity to store SNF until 2032, but strategies for a longer-term solution are being worked on.

The possibility of building a geological repository is under discussion, but no specific location has yet been selected. Geological repositories are considered the safest method of long-term storage, as they isolate radioactive materials from the environment for thousands of years.

In the past, Bulgaria sent spent fuel to Russia for reprocessing. This process extracts valuable materials such as uranium and plutonium that can be reused. The remaining high-level waste is vitrified and returned for long-term storage.

Example from other countries:

Finland and Sweden are among the few countries that are already building geological repositories for high-level waste. These facilities are designed to ensure safety for tens of thousands of years.

Challenges and next steps

Public acceptance: The construction of long-term repositories often meets with resistance from local populations, which requires transparency and dialogue with society.

Geopolitical factors: Changes in international relations can affect the possibilities for exporting spent fuel for reprocessing [19].

Scientific research: The improvement of technologies such as transmutation can offer new solutions for reducing the radioactivity of waste.

Geological repositories are facilities designed for the long-term storage of high-level radioactive waste. They use natural geological formations that provide isolation of radioactive materials from the environment for thousands or even millions of years.

Geological repositories are built in stable rock formations, such as granites, clay marls or salt beds. These materials are resistant to erosion, earthquakes and water intrusion.

- Multi-level containment:
- Radioactive waste is encapsulated in durable containers made of materials such as steel or copper.
- The containers are placed in tunnels or shafts that are filled with barriers of concrete, bentonite clay or other insulating materials.
- Depth of storage:
- Repositories are usually located at a depth of 300 to 1000 meters below the earth's surface, which provides additional protection.
- Monitoring and control:
- Although repositories are designed for passive safety, they are actively monitored in the initial stages to ensure that no radioactive materials are released.

Latest technologies in radioactive waste management

1. Borehole disposal: This technology uses deep boreholes (up to 5 km) to store waste. This allows for deeper and more effective isolation compared to traditional geological repositories2.

2. Transmutation: An advanced method in which radioactive isotopes are converted into less radioactive ones through nuclear reactions. This significantly reduces the long-term hazard of the waste.

3. Vitrification: Radioactive waste is mixed with a glass material and heated to a high temperature to create a stable glass form that is resistant to leakage.

4. Robotic systems: Robots are used to handle and store waste in hazardous areas, minimizing the risk to humans.

5. Digital monitoring: Using sensors and artificial intelligence to continuously monitor the condition of the repositories and provide early warning of potential problems.

These technologies and approaches are aimed at ensuring maximum safety and sustainability in the management of radioactive waste [4], [20].

In Bulgaria and the Balkan Peninsula, various technologies are used for the management of radioactive waste, which meet international safety standards. Here is what is known:

In Bulgaria

1. Dry storage:

o In Bulgaria, spent nuclear fuel from the Kozloduy NPP is stored in special containers of the CONSTOR 440 type, which are resistant to corrosion and mechanical damage. This is the main method of temporary storage.

2. Reprocessing abroad: o In the past, Bulgaria sent spent fuel to Russia for reprocessing, but now long-term solutions are being sought in the country.

3. National repository for radioactive waste: o In Novi Han, there is a specialized repository for low- and intermediate-level waste, which meets modern safety requirements [6], [21].

In other countries on the Balkan Peninsula

1. Romania: Romania uses geological repositories for low- and intermediate-level waste. High-level waste is temporarily stored in dry repositories.

2. Serbia: In Serbia, temporary facilities are used for the storage of radioactive waste, including waste from medical and industrial sources.

3. Greece: Greece mainly manages low-level waste from medical and scientific sources, using temporary repositories.

4. North Macedonia: North Macedonia has small facilities for storing radioactive waste, mainly from medical applications.

Emerging technologies

- There are no geological repositories for high-level waste in the Balkans yet, but opportunities for regional cooperation are being discussed.
- Advanced technologies such as transmutation and vitrification are not widely implemented, but are seen as potential solutions for the future.

There are several significant projects related to the processing and storage of nuclear waste in the Balkan Peninsula and globally. Here are some examples:

Balkan Peninsula Projects

1. Bulgaria:

- National Radioactive Waste Repository: A modular repository for low- and intermediate-level waste is being built in the area of the Kozloduy NPP. This facility is designed to meet international standards and will be key to waste management in the country.
- Geological Repository: Bulgaria is considering the possibility of building a deep geological repository in areas such as Dobrudja or Strandzha. This is part of the long-term strategy for the management of high-level waste.

2. Romania: Romania has facilities for the temporary storage of high-level waste and is actively working on long-term management projects, including geological repositories.

3. Serbia and Greece: These countries mainly manage low-level waste from medical and scientific sources using temporary repositories.

Leading Countries in the World

1. Finland: Onkalo Project: This is the world's first deep geological repository for high-level waste, located in Olkiluoto. The project is an example of sustainable and safe management of radioactive waste.

2. Sweden: Sweden is developing a similar geological repository in the Forsmark area, which will store waste for tens of thousands of years.

3. France: CIGEO Project: France is building a deep geological repository in the Bür area, which will be one of the largest in the world.

4. USA: WIPP (Waste Isolation Pilot Plant): This is an underground repository in New Mexico that stores transuranic waste from military programs.

5. Japan: Japan is actively investing in vitrification and transmutation technologies to reduce the long-term radioactivity of the waste.

These projects demonstrate different approaches to nuclear waste management, focusing on safety and sustainability.

Reports and statistics on the quantities of radioactive waste generated worldwide are not centralized in a single universal table – the data are classified by type of waste (high-level, intermediate-level, low-level) and measured in different units (e.g., spent nuclear fuel in "metric tons of heavy metal" [MTHM], and low-level waste in cubic meters). The data are collected from multiple sources such as the International Atomic Energy Agency (IAEA), the Nuclear Energy Agency (NEA), and national radioactive waste management organizations. However, a rough overview of some of the estimates can be given, which will vary with time and collection methodology. The values below are approximate and serve only to illustrate the comparative scale of waste generated in major countries.

TABLE 1 APPROXIMATE QUANTITIES OF NUCLEAR WASTE

| ***Country Spent nuclear fuel (MTHM)* Other radioactive waste (cubic meters)**** | ***Country Spent nuclear fuel (MTHM)* Other radioactive waste (cubic meters)**** | ***Country Spent nuclear fuel (MTHM)* Other radioactive waste (cubic meters)**** |
|---|---|---|
| USA | ~90,000 | ~250,000 |
| France | ~39,000 | ~90,000 |
| Russia | ~30,000 | ~120,000 |
| Japan | ~20,000 | ~60,000 |
| United Kingdom | ~15,000 | ~50,000 |
| Germany | ~10,000 | ~40,000 |
| Total (world) | 200,000+ | 700,000+ |

\It is important to note that:*

- "Spent nuclear fuel" is measured in MTHM (metric tons of heavy metal) – this represents the amount of nuclear material used in the fuel that has gone through the reactor cycle.
- "Other radioactive waste" includes waste from medical, industrial and research activities, as well as low- and intermediate-level nuclear waste; the measurement in cubic meters reflects the volume of their storage.

Comments and perspectives

1. Continuous updating of data: As new reactors enter or leave service, and decommissioning and spent fuel reprocessing continue, the values are updated periodically. IAEA and NEA central reports provide the most current information, but there is some variation in each publication depending on the methodology.

2. Different waste categories: Data for high-level waste (such as spent nuclear fuel) and low/intermediate-level waste are presented differently because the way in which it is generated, processed and stored differs by category and country.

3. Possibility of regional tables: Some countries or regional groups (e.g. the European Union) publish their own tables and reports, which can be found on their websites or in international publications. They focus not only on the quantity, but also on recycling, reprocessing and long-term storage strategies.

4. Recommended sources: For the most accurate and up-to-date information, it is recommended to consult the latest reports of the IAEA and NEA, as well as the national atomic energy agencies in individual countries.

In conclusion, although there is no universal and static table of radioactive waste generated for all countries, there are many assessment tables that are updated periodically. The sample table presented above provides an indicative comparison of the scale in some of the largest users of nuclear energy.

Nuclear waste recycling takes place in specialized facilities that are equipped to process spent nuclear fuel. Here are some key locations and prospects:

Where recycling takes place

1. France: France is a leader in nuclear waste recycling through facilities like those in The Hague. They extract valuable materials like uranium and plutonium that can be reused.

2. Russia: Russia has modern nuclear fuel reprocessing facilities that serve both domestic and international customers.

3. Japan: Japan is actively investing in recycling technologies, including vitrification of high-level waste.

4. USA: Although recycling is not widespread, the USA has pilot projects for nuclear fuel reprocessing.

Prospects for recycling

1. Technological innovation: Improvements in technologies like transmutation and vitrification could make recycling more efficient and safer.

2. Sustainable development: Recycling reduces the amount of high-level waste and supports nuclear energy as a low-carbon source.

3. International cooperation: Countries like Bulgaria can benefit from the experience of leading countries through partnerships and technology exchange.

4. Economic benefits: Recycling can reduce the costs of long-term storage and provide valuable resources for reuse.

## IV. Conclusions

The conclusions on radioactive waste storage in Bulgaria and around the world can be summarized in the following areas:

1. The need for long-term solutions, because radioactive waste, especially high-level waste, requires safe management for thousands of years. Geological repositories are the most reliable long-term solution and are accepted as the standard in many countries.

2. Technological modernization, where dry storage and vitrification are proven methods for reducing the risk of leakage. Advanced technologies such as transmutation can significantly reduce the radioactivity of waste.

3. International cooperation, where countries like Bulgaria rely on imported technologies and knowledge exchange with countries like Finland, France and Sweden, which are leading in the construction of modern repositories.

4. Overcoming the challenges of public discussion and acceptance of the construction of radioactive repositories for intermediate and high-level radioactive waste, as the population of the selected region often opposes the construction of repositories. Transparency of proposals and discussions and public consultations are key to the successful implementation of these projects.The prospects for the industry can be summarized as:

1. Investment in innovation, where the development of technologies such as transmutation, borehole disposal and digital monitoring opens up new opportunities for safe management.

2. Sustainable development, because the recycling of spent fuel and the use of nuclear energy as a low-carbon source support the global transition to sustainable energy.

3. Expansion of geological repositories, because more countries are expected to build their own repositories for long-term storage, which will reduce dependence on waste exports.

4. Increasing public trust. By improving transparency, communication, and safety, the industry can strengthen citizens' confidence in nuclear energy.

Overall, the future of radioactive waste management will depend on a balance between innovation, effective planning, and social support.

## ACKNOWLEDGMENTS:

This report is supported by the National Scientific Program "Security and Defense", approved by Decision No. 171/21.10.2021 of the Council of Ministers of the Republic of Bulgaria.

## REFERENCES

[1] Annual Report NRA,the Council of Ministers, Sofia, 2015.

[2] Commission Regulation (Euratom) No 302/2005 of 8 February 2005 on the application of Euratom safeguards - Council/Commission statement, OJ L 054 28.02.2005 pp. 1-3.

[3] Commission Regulation (EC) No 1609/2000 of 24 July 2000 establishing a list of products excluded from the application of Council Regulation (EEC) No 737/90 on the conditions governing imports of agricultural products originating in third countries following the accident at the Chernobyl nuclear power station, OJ L 185 25.07.2000 pp. 27-39.

[4] Communication from the commission to the council and the european parliament. Communication on nuclear non-proliferation, Brussels, 26.3.2009, pp= 3-6.

[5] N. Dolchinkov, Investigation of the State of the Radiation Control Systems and the Actions of the Competent Authorities and the Population in the Event of a Change in the Radiation Background in Bulgaria, International conference Knowledge-Based Organization Subuy, Romania 24(3): pp.38-44

[6] N. Dolchinkov, N. Nichev, Gamma-background radiation control systems as a factor of Bulgaria's national security, Environment. Technology. Resources. Rezekne, Latvia, Proceedings of the 15th International Scientific and Practical Conference. Volume IV, Print ISSN 1691-5402, Online ISSN 2256-070X, pp. 83-88, DOI 10.17770/etr2024vol4.8225

[7] N. Dolchinkov, N. Nichev, Structure and Management of the National Automated System for Permanent Control of the Radiation Gamma Background in Bulgaria, De gruyter open, Land Forces Academy Review Vol. XXII, No 2(86), 2017, Sibiu, Romania, pp. 115-121.

[8] R. Marinov, S. Stoykov, P. Marinov, Urbanized territories non-existing part of crisis response operations, International Conference on Creative Business for Smart and Sustainable Growth, CreBUS 2019, 2019, 8840084

[9] N. Dolchinkov, Historical overview and analysis of national automated system for continuous monitoring of gamma radiation, VIII науково-практичного семінару з міжнародною участю "Економічна безпека держави і науково-технологічні аспекти її забезпечення", Київ, 21-22 жовтня 2016 року ISBN 978-966-7166-38-0 pp. 220.228

[10] L. Lazarov, General Terms and Conditions for the Radio Connection Jamming, International Conference on High Technology for Sustainable Development, HiTech 2018 - Proceedings, 2018, 8566645

[11] D. Stefanova, V. Vasilev, I. Efremovski, Re-Innovative Organizational Design: Sustainable Branding and Effective Communication - Applied Models in a World With New Borders/Without Borders;; Book Chapter: Handbook of Research on Achieving Sustainable Development Goals With Sustainable Marketing, 2023, pp. 112–127; DOI: 10.4018/978-1-6684-8681-8.ch006;

[12] N. Todorov Dolchinkov, State of the population disclosure systems in the changing radiation situation in Bulgaria, Vide. Tehnologija. Resursi - Environment, Technology, Resources, 2019, 1, pp. 54–58

[13] N. Dolchinkov, Modernization of monitoring and public notification systems in case of radioactive pollution of the environment in Bulgaria, Scientific and Practical Journal "Global Nuclear Safety", No. 3 (24) 2017, Moscow, MEPI, Russia, pp 7-18.

[14] S. Stoykov, The System Of Education, Training And Research In The Field Of Security - Managing Change Through Experience And Knowledge, Vide. Tehnologija. Resursi - Environment, Technology, Resources, 2024, Volume 4, pp. 269–274, Print ISSN 1691-5402, Online ISSN 2256-070X, DOI: https://doi.org/10.17770/etr2024vol4.8213

[15] N. Dolchinkov, Optimization of the systems for monitoring and public disclosure of radioactive contamination of the environment,International journal „Knowledge ", Skopie ISSN 1857-92 Vol 15.1 p. 423-431 GIF 1.023 (2015) . Available: https://www.researchgate.net/publication/320378173

[16] S. Vambol, N. Dolchinkov, V. Vambol, S. Abbas, S. Yeremenko, O. Trush, Mathematical modeling study of the process of transfer radioactive contamination from the Chernobyl accident zone, Journal of Mountain Area Research, ISSN: 2518-850X (Online), 2518-8496 (Print), 2024

[17] N. Dolchinkov, Optimizing energy efficiency in the conditions of a global energy crisis, Optimizing Energy Efficiency During a Global Energy Crisis, 2023, ISBN13: 9798369304006 EISBN13: 9798369304013, DOI: 10.4018/979-8-3693-0400-6 pp. 1–9.

[18] N. Padarev, Anthropogenic accidents and catastrophes, PIK Publishing House, VT, 2016, pp 5- 235.

[19] M. Pavlov, The radiation consequences of accidents at nuclear power plants and the use of nuclear weapons, Scientific conference "Radiation safety in the modern world", NSU "V. Levski" - city of V. Tarnovo - November 22, 2019 ISBN 2603-4689, pp. 84-90

[20] S. Lilianova, N. Padarev, Radiation incidents with radioactive waste Collection of reports from a scientific conference of the National University "V. Levski", Volume 4, V. T. 2018, ISBN 1314-1937

[21] V. Vasilev, D. Stefanova, M. Icheva, Green human resource management as a component of sustainable organizational development in environmental and natural economics, ETR, vol. 1, Jun. 2024, pp. 402–407 DOI: 10.17770/etr2024 vol1.7966