STUDY AND EVALUATION OF EXISTING AND FUTURE NUCLEAR POWER IN SOUTH EASTERN EUROPE

ИЗСЛЕДВАНЕ И ОЦЕНЯВАНЕ НА СЪЩЕСТВУВАЩИТЕ И БЪДЕЩИТЕ ЯДРЕНИ МОЩНОСТИ В ЮГОИЗТОЧНА ЕВРОПА

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Abstract: *With regard to the nuclear power stations located near Bulgaria, we will look at the sites that would have an impact on the change of the radiation gamma background on the territory of our country. We will also consider the possible new nuclear power plants near our border and sites where nuclear installations could be located.*

Keywords: *nuclear power, NPP, nuclear installations, radiation gamma background, accident*

1. Introduction

In view of the nuclear capacities near Bulgaria, we will look at the objects that would influence the change of the radiation gamma background on the territory of our country. We will also consider the possible new nuclear power plants near our border and sites where nuclear installations could be located.

Bulgaria borders directly with Greece and Turkey to the south, Macedonia and Serbia to the west, Romania to the north and the Black Sea to the east.

2. Location of nuclear facilities in the region

In our southern neighbor, Greece has no nuclear capacities and it is not envisaged to build such facilities in the foreseeable future. It is not known to have operating accelerators or other sources of ionizing radiation in an area 100 kilometers from our border. There are sources of radiation in medical institutions in 3 cities - Thessaloniki, Alexandroupolis and Kavala, located in northern Greece, which can not influence the radiation background in our territory due to their low power and the type of ionizing radiation used in them. In industry and mainly in the food sector, such sources are not used for different purposes. There are no vessels in the adjacent Aegean Sea where there are sources of ionizing radiation present and those in which a nuclear reaction could normally occur. The Army of Greece does not have weapons that would, after use, alter normal atmospheric parameters. In the bases of Greek territory, where troops from other countries (USA) are located, there are no nuclear-weapon based weapons.

Similarly to Greece and our Sister Macedonia, there are no nuclear power plants, other types of nuclear reactors or accelerators where significant amounts of ionizing radiation can be emitted. In the field of economy and technology, there are no enterprises and institutes that are potentially dangerous to increase the radioactive background on the territory of Bulgaria as a result of a possible accident. Sources of ionizing radiation with a small dose are located in the hospitals "Ajabadem" and two more in Skopje, which are used for medical purposes. The Macedonian Army does not have nuclear weapons or the like. There are no weapons of mass destruction on the territory of Macedonia that would increase the radioactive background after use.

Our other western neighbor, Serbia, also does not pose a threat to our safety from the point of view of radiation protection. Near the Bulgarian borders there are no industrial sites that use sources of ionizing radiation with medium and large doses of load. Due to the country's specificity and the lack of large settlements in the eastern regions of the country, there are also large medical diagnostic and health establishments in which to use equipment with significant exposure power. Industrial and medical sites that have sources of ionizing radiation with moderate and higher exposure are located in Belgrade or cities located far from the Bulgarian border and practically in case of an accident they would very hardly have an impact on the radiation situation in Bulgaria. The Serbian army does not have nuclear weapons and there are no such weapons in the territory of Serbia. There is an agreement between Serbia and Russia on mutual assistance and, if necessary, Russia can supply such a weapon on Serbian territory. In practice, this is very difficult to achieve in the current international environment because neighboring countries will not open their airspace for such supplies.

The Serbian side was interested in the Belene project, where it wanted to finance part of the construction against a corresponding shareholding in the plant. In this way, it wanted to provide electricity for itself and eventually to participate in the regional electricity market. Serbia's current process of development has not commented on its involvement in restarting the project [1].

The closest sites potentially hazardous to radioactive contamination following an accident and located west of us are Pakistani NPP in Hungary and Krusno NPP on the border between Slovenia and Croatia. Taking into account their location, their remoteness from Bulgaria, the prevailing winds and the EURDEP system, we can exclude them from the analysis and ignore their impact.

These are the countries and sites that pose a very minor threat to a possible nuclear accident and consequently change the natural radioactive background over Bulgaria. In the analysis of the state of NASCRRF and the available points in the vicinity of these countries, I believe that the system is fully in line with modern requirements and the international environment. As a result of research into sites in Greece, Macedonia and Serbia, which are sources of ionizing radiation in the development, we exclude a possible danger of radioactive contamination from these sources.

There is a significant difference in the possible threat from our other border regions and neighboring territories.

In our northern neighbor, Romania has a "Black Water" NPP, which is located on the Danube River 60 km after Silistra and about 40-50 km by air from our state border. The first reactor was built jointly by the Canadian company Atomic Energy of Canada Limited and the Italian Ansaldo and was put into operation on 2 December 1996. It is constructed using CANDU technology and has a power output of 620 MW. The second reactor was put into operation in 2007 and is of the same type. The project to build a third and fourth reactor of Romania's nuclear power plant "Cherna Voda" is part of Romania's energy strategy, as over EUR 1 billion has been invested in this project, said Energy Minister Victor Grigorescu in 2016, quoted by "Adjuster"[2]. Grigorescu pointed

out that nuclear power is one of the sources by which the country's energy security is strengthened. In his words, the project also makes sense in terms of reducing the use of coal to produce electricity, as currently 30% of Romania's electricity is generated by the thermal power plant. Romanian President Klaus Johanis also called the project for the expansion of the Chernapa NPP as a "priority investment" for the country.

The Romanian State Energy Company (SNN) and China's General Electric Nuclear Power Corp. (CGN) signed on November 9, 2015, a Memorandum of Understanding on the design, construction, operation and decommissioning of third and the fourth unit of the NPP "Cherna Voda". The agreement is the basis for a joint project company, in which no less than 51 percent will belong to CGN, SNN said.

The project envisaged the construction of five power units. In 2015 -2016 another two blocks of the same type were planned to be put into operation, which would cost investors (seven Romanian and international companies) another 4 billion euros. Romanian nuclear power company Nuclearelectrica believes that by the end of the year, it will reach agreement on the completion of the Third and Fourth Unit of the Cherna voda NPP with the Chinese group "China General Newark Power Corporation", which was announced as early as 2015 for the winner of the tender organized by the Romanian state. Fifth block is still frozen [3].

The signed Memorandum forms part of the state strategy of selecting the investor of the project and defines the "direction of the future cooperation" between the parties. "SN Nuclearelectrica SA" and "China General Nuclear Power Corp." reached the final stage of the investor selection procedure launched in August 2014 and start discussing the investment agreement and the founding agreement of the new project company, the SNN .

The CANDU 6 heavy water reactors will be installed on both 700 MW units of the second stage of the Cernavoda NPP, similar to those of the first and second power units.

Specialists are alarmed by the fact that part of the equipment is obsolete, not renewed, and the work teams are not sufficiently prepared. Part of the staff serving nodal points has left in the past 2 years and works at other nuclear sites in Europe for higher pay. The headquarters in Romania were verified by the International Agency for the Use of Atomic Energy for Peaceful Purposes under the OSART Safe Operation Program from 7 to 24 November. The mission was second for the Romanian headquarters and covered 10 areas: management and leadership, training and qualification, operation, repair, technical support, operational experience feedback, radiation protection, chemistry, emergency preparedness and severe accident management. OSART missions aim to establish the level of safety at individual nuclear power plants and are applied by the IAEA worldwide. The new element in controls - related to the management of severe accidents, was introduced after the events at Fukushima NPP in 2011. In accordance with IAEA rules, the mission has completed a report with described recommendations and good practices, which, after being endorsed by the International Agency, will be publicly available to the public.

The uncertainty in the project to complete the new 2 blocks, the outflow of a number of Western investors from the project conceals it with unpredictability and ambiguity, similar to our Belene project. The fact is that in 2014 the plant was forced to stop 6 times, and in 2015 - 4 times. The location of the "Cherna Voda" NPP and the prevailing winds in the area, according to NIMH data for the past 5 years, make it a serious potential pollutant of Northeastern Bulgaria in the event of a nuclear accident [4].

The Black Sea port of Constanta has developed very fast over the last decade. In addition to its commercial significance, it is becoming more and more of military significance, and many NATO navy ships have been moored there. The American Karneys, equipped with an Aegis Information System ("Idys"), was at the end of 2016 in the Romanian Constanta harbor. The permanent base of Carney and other American ships is the Spanish port of Rota. Carney is armed with manned missiles. Together with the rosters, Porter and Donald Cook, as well as the Ground Anti-Missile Defense (PRO) ground units in Romania and Poland, also equipped with the IGIS system, they are parts of the European segment of the American PRO. The Montreux Convention in 1936 limited to 21 days the rescue of warships of non-Black Sea countries in the Black Sea. That's why the rockets of these military craft are being made.

The presence of the Cherna Voda NPP and the increased shipping and the use of the port in Constanta are alarming as potential contributors to the increase of the natural radioactive background in the region of Northeastern Bulgaria. This necessitates possible changes and optimization of NASCRTF in this area.

In the central part of Southern Romania, about 40 km north of the Bulgarian border, in the village of Zagradzhden, Pleven district, is the former Air Force Airport of Romania to the village of Deveselo. Since mid-2016 there is a USA base, which is part of NATO's anti-missile defense strategy. NATO should thus receive 24/7 protection, integrated with radars and US missile defense systems already deployed in the Mediterranean.

In place of Romania's former Air Force Base, there are 24 SM-3 missiles and Aegis system radar. The Aegis Ashore "Land Shield" system includes powerful radar, interceptors and a communications system. It is the first of its kind in Europe. The shield will be fully integrated into NATO's wider defense system against ballistic missiles from potential enemies.

There is a serious concern and the public opinion of military scientists on the transfer of 20 atomic missile missiles from the Inzhirlik base (Turkey) to this Romanian base. Following the attempted coup in Turkey in the summer of 2016, and the recent events, talked about the security of the large American base and the weapons located there. Relations between the United States and Turkey were severely tightened, and in view of Turkey's request for extradition to 78-year-old Islamic preacher Fethullah Gullen, who lives in the United States and is accused by Turkey of organizing the failed coup on July 15, 2016. The unpredictability of Turkish President Recep Tayyip Erdogan is a prerequisite for these views of military strategy specialists.

But the presence of nuclear-powered missiles at 40 km from the Bulgarian border can not leave us indifferent to them and their storage. Despite good relations with Romania and NATO's partnership in such developments, we must take care of our radiation security and be prepared to deploy another point of the NASCRPF system to monitor the radiation background in the Zagrazhden and Gigen villages . This point would also be effective in terms of restarting the Belene project.

There are currently four active NPPs with 15 nuclear power units and a total power of 13,835 MW, according to Oleksandr Syor, PAO Radiy NPP, Ukraine [5]. For the last ten years, Ukrainian nuclear power plants produce half of the country's electricity. Ukraine's energy strategy provides for this share to be preserved by 2030. It is also foreseen to extend the lifetime of active energy units. In 2010, it was decided to extend the lifetime of Units 1 and 2 of the Roven NPP by 20 years. At the end of 2013, life was extended to 10 years and to Unit 1 of the South-Ukrainian NPP. By 2018 this will happen with another 9 blocks.

The electricity from the NPP in Slovakia is over 55% in the total energy balance. There are four units - two of Bohunice NPPs and two more of Mohovce NPP - the reactors are VVER-440, produced by the Russian company Rosatom. All of them are built on a Russian project.

Upon the entry of Slovakia into the European Union at "Bogunice" in 2006 and 2008 two blocks were stopped. They worked from 1984 and 1985. Then the country began to import electricity because a certain shortage arose. Hence, the desire to build a new block is completely logical. And the fact that Rosatom as a solid performer makes proposals on a legitimate basis is a normal business.

The Czech Republic operates 2 NPPs with 6 reactors. Temelin NPP has two power units with Sovereign WWER-1000 reactors and an electric power of 1000 MW. The second Czech Dukovany NPP was built by Soviet specialists in the period 1974-1987. There are 4 units with WWER-440 B-213 reactor units.

The Paks NPP operates in Hungary, which has 4 WWER-440 units and produces about 40% of the country's electricity. It was built in 1980 and is the only nuclear plant in Hungary.

The decision to build two new reactors was taken by the Hungarian Parliament in 2009 but the announcement of a tender for the construction was postponed several times. Rosatom, the Russian state-owned company, will finance and build two new nuclear blocks in the Hungarian Pakistani nuclear power plant, which will double the capacity of the plan Paks NPP t. In addition to Rosatom, interest in the project was claimed by Areva and Westinghouse.

Although we do not have a land border in the east, we can not be calm about the events that happen in the Black Sea. Over the last 5 years, we have an increased presence of military equipment, including one that has or could have deployed nuclear-powered missiles. The reasons for the increased presence of such a technique can be summarized in:

• The expansion of the USA and NATO missiles to the east;

• The military conflict between Ukraine and Russia, the problems in the Crimea and the military bases of Russia in the former Ukraine on the territory of the Crimea;

• The conflict in the Middle East, involving many countries in the region - Turkey, Russia, Syria, etc., as well as a large part of the Great Powers;

• The expansion of Terrorists from the Islamic State and other organizations close to it.

The presence of large vessels of Russia, the United States and NATO in the Black Sea, the continual lurking, the use of aviation and other actions continually escalate the situation near our state border. This leads to an upsurge in the situation, and a wrong move or action can cause undesirable consequences for us and the region.

In this direction we can optimize the control system by analyzing and adding, if necessary, 1-2 points, in addition to the available stations of Cape Kaliakra, Varna, Cape Emine and Ahtopol.

The last critical direction from the point of view of radiation security is our southeastern border and Turkey in particular. During the last year there have been significant political and economic changes. Turkish President Recep Tayyip Erdogan, following an unsuccessful coup attempt, made very great political changes in our southern neighbor. Relations with the United States have been greatly complicated, even in the military, where cooperation between the two countries was one of the best in the world. Even talk of ending the activities of the Inzhirlik military base - the largest US base in the Mediterranean.

After the freeze of relations between Russia and Turkey when the Su-24 bomber was shot down by Turkish fighters in the sky over Syria on November 24, 2015, there was a sharp warming in 2016 and a re-launch of many significant economic projects. The construction of the Akkuku nuclear power plant from Russia is restarted, and the construction of the Sinap NPP on the Black Sea coast from France and Japan soon begins. The Turkish president intends to start construction of a third nuclear power plant, one of the sites under consideration being located 20 kilometers south of Rezovo on the Black Sea coast. There is no decision yet to choose a site, but the Bulgarian side should carefully monitor closely the developments in the neighboring country.

Turkish Energy Minister Taner Yildiz and Rosatom Director Sergei Kiriyenko took part in the Aquarium on the Mediterranean coast in Mersin County near Syria in a ceremony for laying the first stone of the construction of the first of the four reactors, which will be with 1200 megawatts. Construction work started in mid-2015 [6]. After the cooling of Russian-Turkish relations the work was terminated, but in recent months the construction of this strategic site has begun. Electricity production is expected to start in 2020.

Besides the nuclear power plant in Akkuu, Turkey plans to build a second nuclear power plant in Synop County, on the Black Sea coast. This EUR 15 billion project was awarded in 2013 to a consortium comprising the Turkish company "UEAS", the Japanese companies Mitsubishi and Itochu and the French "Zee de Suez". "Mitsubishi Heavy Industries" and "Areva" offer their jointly developed Atmea-1 reactor with a capacity of 1100 megawatts.

Bearing in mind the unpredictability and decision-making nature of the Turkish Head of State, we should be prepared for various actions on his part and ready-made options for action to preserve the radiation safety of Bulgaria.

This is not to neglect the refugee flow from Turkey to Bulgaria and its external regulation. In these masses, composed mostly of young men, can safely be transported through the unregulated places where they cross the state border and dangerous radioactive materials. They can then be used unlawfully to infect our or other territories and increase the radioactive background.

As a result of the research conducted on sources of ionizing radiation in Romania, the Black Sea and Turkey, we exclude small sources in medical institutions, industrial plants and institutes and we focus on the "Black Water" Base in Deveselo, the Constanta port in Romania, the floating warships and the presence of large aircraft airplanes in the Black Sea and the potential new nuclear power plant in Turkey.

The idea of other nuclear fuel manufacturers to deliver to Russian-made nuclear power plants was criticized by experts in Europe. This is written by the Russian agency RIA Novosti in its analysis. International experts point out that this may cause economic risks. In addition, there is no guarantee that the second manufacturer as a "mandatory supplier" will also offer favorable terms or provide reliable fuel [7].

The mandatory availability of alternative nuclear fuel suppliers for European NPP reactors built on Russian or Soviet projects is inappropriate for a number of reasons. These include economic and nuclear safety issues. Around this, the participants took part in a round table held at the 10th European Conference on Nuclear Energy organized by Platts in Brussels [8].

Earlier, it was reported that European companies operating nuclear power plants with Russian WWER reactors must have at least two sources of nuclear fuel delivery. This scheme is backed by the US producer of nuclear fuel Westinghouse. Earlier international experts have repeatedly noted that this position does not meet free and fair market relations, says RIA Novosti.

Round table participants also criticized the idea of diversifying nuclear fuel suppliers at all costs.

"There may be economic risks," one of the founders of Trusted Sources, Christopher Grenville, [9] said. It's about consumers being interested in buying high-quality and proven fuel from a reliable supplier. And, at the same time, there is no guarantee that the second manufacturer as a "mandatory supplier" will offer such favorable terms or will deliver fuel of a reliable quality. Significant financial difficulties have been experienced by the US Westinghouse in recent years. Even in March 2017, Japanese company Toshiba, which owns the majority stake in the company, demanded bankruptcy of the company, with the exception of the European and Asian branches [10].

In addition, in the use of Russian (Soviet) fuel reactors by another manufacturer, risks may arise from the point of view of nuclear safety issues due to the technical differences of the fuel components themselves and of the fuel itself.

Ute Blom-Heber, a representative of the European Atomic Energy Community (Euratom), noted that the Agency did not insist on the necessity of two or more suppliers of fuel. "This question must be solved by the plant operators themselves," Bloom-Heber said.

Despite the pressure from the United States, the European Union must necessarily diversify sources of nuclear fuel delivery to its Russian-designed nuclear power plants to break the Kremlin's energy dependence, so far, the idea remains in the political field rather than seeing it a real economic benefit and a guarantee of technical safety.

At the end of last year, a political agreement was reached on the revised Nuclear Safety Directive. "Nuclear safety is of paramount importance to all European citizens, and we must make every effort to ensure that the highest safety standards are observed in every nuclear power plant in the EU. This directive, once it has been formally adopted, will help ensure the continuous improvement of

the safety of our nuclear installations, "said EU Commissioner Günther Oettinger.

The revised Directive will strengthen the role and independence of national regulators and will help to increase transparency on nuclear safety issues. It will introduce a system of European peer reviews to be carried out at least once every ten years. It will also ensure that European nuclear safety rules are in line with the latest international standards

By March 2016, Europe has 185 nuclear capacities with a net capacity of 162 GW (5 of which are in the Asian part of the Russian Federation), and 17 other nuclear units with a net capacity of 15 GW are being built in five countries.

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Nuclear science and experimental base is a laboratory of the Institute of Nuclear Research and Nuclear Energy of the Bulgarian Academy of Sciences. It includes the only research nuclear reactor in Bulgaria located in the south-eastern part of Sofia.

The initial research reactor of the Nuclear Research and Experimental Base in Sofia is from the Soviet IRT-2000 model. Its construction began in 1956, and its launch was in 1961, when at 20:15 on September 18 the first nuclear chain reaction in Bulgaria was carried out. Initially, the thermal power of the reactor is 500 kW, but five years later it reaches 2000 kW.

IRT-2000 was temporarily suspended on July 13, 1989 on a CUAEPP prescription for security reasons following the Chernobyl accident. After the reactor shutdown, the spent fuel is stored in the territory of the Institute on Tsarigradsko shosse Blvd. - VII km in Sofia. Removal of the 70 spent fuel tanks is enshrined in the Reconstruction and Reconstruction Agreement for the Reactor for Research Purposes. At the beginning of this century, the reactor was finally shut down.

The fuel is discharged in two stages. The first stage was carried out at the end of December 2003. 16.9 kg of enriched uranium was transported with a 36% concentration of 235U (uranium-235), which equals 28 fuel elements for the IRT-2000 reactor. The fuel is transported by truck to Gorna Oryahovitsa Airport, where a Russian cargo plane An-12 supplies it to the Research Institute for Atomic Reactors (NIIAR) in Dimitrovgrad, Ulyanovsk Oblast, Russia. The transportation operation has been prepared by 35 Russian, American and Bulgarian specialists, while the $ 440,000 costs are covered by the US side.

The second stage takes place in early July 2008. 6.3 kg of enriched uranium 235U is transported. The fuel was transported by truck to a Danube port, from where a barge transported it to the Ukrainian port of Izmail. From there, a special train was delivered to Sheikh Mohammed in Chelyabinsk, Russia [11].

In our experimental reactor everything that is outside of the core zone and next to it is replaced, but in the past 2 years, any funding has been suspended and is in standby mode. A Decree of the Council of Ministers for reactor modernization is in force, but there is no real funding for the project. In fact, about 5 million levs are needed to complete the reconstruction, which the Bulgarian governments do not find.

In 2015 a cyclotron was delivered to the RNI to BAS. It is a cyclic particle accelerator, in which the particles move in a constantly homogeneous magnetic field, and their acceleration is applied to a high-frequency electric field at a constant frequency. It is still in cartons and has not been tampered with, although the media have repeatedly released messages about its commissioning [12].

Cyclotron works with unrelative heavy charged particles (protons, ions). It was first developed and built in 1931 by Ernest Lawrence, for which he was awarded the Nobel Prize for Physics in 1939. To date, cyclotrons are used to accelerate heavy particles to relatively small energies - up to 50 MeV / nuclon. In the summer of 2016, it was going to be put into operation, with which we would produce neutrons and isotopes for our medicine and technology. Currently, isotopes for PET scanners are mainly imported from Hungary and the Czech Republic. On the territory of the country there are already a few small cyclotrons specializing in the production of Fluoro-18. One in Plovdiv, one in Varna and two in Sofia. Unfortunately, they are insufficient to meet demand, and most are still not in operation but under licensing. Unfortunately, the much needed sources of neutrons and isotopes for our medicine and industry for many reasons fail to work well.

Neighboring with us experimental nuclear reactors or powerful accelerators have Romania, Hungary, the Czech Republic, Slovakia and Ukraine.

3.Conclusions:

1. A clear program has been developed and implemented to ensure nuclear safety with the participation of all levels of state and local government. A National Strategy for the Safe Management of Spent Nuclear Fuel and Radioactive Waste has been developed and the necessary control has been introduced on these activities;
2. Near Bulgaria there are nuclear facilities in Romania and planned in Turkey, which could potentially affect the radiological situation in Bulgaria in the event of a nuclear accident. There is also such a strong military presence in the Black Sea, which is not a constant magnitude. This implies the strengthening of control in these border areas, and we must not overlook the other potentially dangerous areas.

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