

Nuclear Weapons – Risks in Case of Their Potential Use

Stefko Burdzhiev

Department of Security and Safety
Varna Free University "Chernorizets Hrabar"
Varna, Bulgaria
stefko.burdzhiev@vfu.bg

Maria-Magdalena Burdzhieva

Faculty of Pharmacy
Medical University - Varna
Varna, Bulgaria
maria-m_burdzhieva@abv.bg

Abstract—The aim of the research is to evaluate nuclear weapons risks in the case of their potential use. It is known that the properties of a particular radioactive isotope do not depend on the method of its formation, since no fundamental boundary can be drawn between natural and artificial radioactive substances. From a biological point of view, two types of radioactive substances are distinguished. If people have been in contact with natural radioactive substances since their existence, then artificial radioactive substances first appeared in the biosphere in 1945, immediately after the first nuclear weapons tests, in particularly after their use over the Japanese cities of Hiroshima and Nagasaki. A nuclear explosion differs from an explosion of ammunition loaded with conventional explosives, where almost all the energy is released as kinetic (thermal) energy, and the destructive effect is mainly concentrated in the blast (shock wave). The strong electromagnetic field (EMF) can induce electric current in antennas, cables, power lines and sensitive electrical and radio equipment. As a result, cables and wires can melt, equipment can burn out and insulation can be damaged. The radius of destructive effect of EMP depends on the type of explosion and the power of the nuclear weapon. According to American experts, the radius of destructive effect of a low-altitude air explosion with a power of 1 Mt is 32 km; for 10 Mt it is 115 km; and for 50 Mt it is 190 km. Long-lived radioisotopes also include cesium-137, cesium-144, ruthenium-106, zirconium-95, etc. The main contamination threat to plants and plant products is strontium-90. The destructive effect of a shock wave on people, animals, plants and objects is determined by the overpressure in kilograms per square centimeter and the duration of the shock wave. The overpressure varies depending on the distance from the center of the explosion.

Keywords— Nuclear use, Nuclear weapons, Risks.

I. INTRODUCTION

In the context of an increasingly complex external security environment, the likelihood of using nuclear

weapons is growing.[1] With military operations taking place in Ukraine and the Middle East, this danger should not be underestimated [2]. This is the primary reason to examine at least some of the impacts and problems associated with their potential use on the environment, biosphere, infrastructure, material, and cultural values.[3]

It is known that after the discovery of the fission of heavy element nuclei, nuclear energy began to develop. The development of this new scientific field is associated with the appearance of artificial radioactive substances in the biosphere.

It is known that the properties of a given radioactive isotope do not depend on the method of its formation, as no principal boundary can be drawn between natural and artificial radioactive substances. From a biological standpoint, two types of radioactive substances are distinguished. If humans have been in contact with natural radioactive substances since their existence, artificial radioactive substances first appeared in the biosphere in 1945, immediately following the first nuclear weapon tests, notably after their use over the Japanese cities of Hiroshima and Nagasaki.

As is known, nuclear weapons are called bombs, missiles, and shells, whose action is based on the release of intra-nuclear energy. This energy can be released as a result of the fission of heavy element nuclei, the fusion of light elements, or a combination of these two processes. The energy of explosion of the charge of the normal explosive substance (BB) is released as a result of a chemical reaction, during which the explosive molecules become more resistant molecules of the explosive products. In these explosions the atoms do not undergo any alteration [4]

The so-called thermonuclear bomb is based on the principle of fission-fusion-fission [5]. Upon detonation of the atomic device included in this bomb, a vast amount of energy is released, causing the fusion of the nuclei of light

Online ISSN 2256-070X

<https://doi.org/10.17770/etr2025vol5.8496>

© 2025 The Author(s). Published by RTU PRESS.

This is an open access article under the [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

elements (deuterium - D, tritium - T) in the shell. The fusion is accompanied by the formation of fast neutrons with an energy of $E = 1,1$ MeV (Mega-electron volts), which induce the fission of the material of the outer shell made of metallic uranium.

The power of atomic weapons is usually expressed using the TNT equivalent. The TNT equivalent of a nominal atomic bomb is about 20,000 tons of trinitrotoluene (TNT). The first attempt to split the atomic nucleus was made by the German physicist and chemist Otto Hahn (1879-1968) on December 22, 1938. Otto Hahn is one of the founders of radiation chemistry, and in 1944 he received the Nobel Prize in Chemistry for the discovery of nuclear fission (in uranium). His work and discoveries fundamentally changed the course of humanity, providing the key to the use of nuclear energy—the atomic bomb and nuclear reactors.

Nuclear explosions involve extremely complex physical processes, some of which are visible and provide the corresponding external picture of the explosion, while others are hidden but have extremely important significance for forming the damaging factors of this weapon. At the core of all processes is the redistribution of intra-nuclear energy released during the chain and thermonuclear reactions [5].

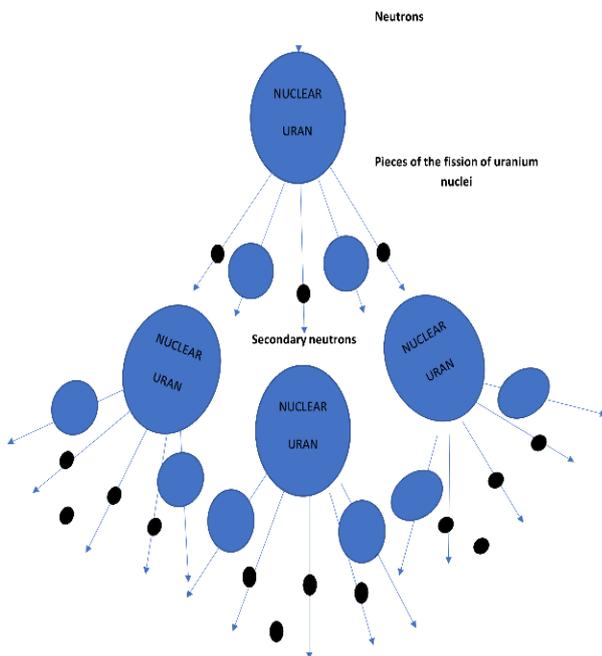


Fig. 1. Diagram of the Chain Reaction.

The external appearance of a nuclear explosion, as well as the effect of its destructive factors, primarily depend on the type of explosion, i.e., the location of its centre relative to the Earth's surface. We consider the following classification of nuclear explosions to be the most accurate and convenient:

- a) Air explosion

- b) Surface (above-ground or above-water) explosion
- c) Underground (underwater) explosion

The explosion of nuclear munitions differs from the explosion of munitions loaded with conventional explosives, where almost all the energy is released as kinetic (thermal) energy, and the destructive effect is mainly concentrated in the blast (shock) wave. In a nuclear charge, the released energy is distributed in a completely different way. Here, only 85% of the energy manifests as kinetic (thermal) energy, of which 50% is used to form the shock wave and 35% to produce light radiation. This is explained by the fact that in a chain reaction, the temperature rises to tens of millions of degrees. A luminous zone is formed, emitting ultraviolet, infrared, and visible rays. The remaining 15% of the energy released during the explosion is nuclear radiation (gamma rays and neutrons), which act at the moment of the explosion (initial radiation) and radiation that is released over a relatively long period of time from the formed radioactive products (residual radiation) [5].

Nuclear weapons are called munitions whose destructive and damaging action is based on the use of atomic nucleus energy. They are one of the most powerful and dangerous types of weapons of mass destruction.

The following types of nuclear weapons are known: nuclear (uranium or plutonium), thermonuclear, and neutron. Nuclear munitions are based on the principle of using the energy of a chain reaction during the fission of uranium-235 or plutonium-239 nuclei, which are easily split into two halves by the impact of slow neutrons. The formed secondary neutrons cause the fission of other nuclei, which in turn ensures the continuity of the reaction (Fig. 1). It is enough for a wandering neutron to split just one uranium or plutonium nucleus, and the fission begins to grow avalanche-like. This instantly leads to the fission of all nuclei, i.e., to an explosion. In this process, a huge amount of kinetic energy of atomic nucleus particles is released, which move at enormous speeds in different directions.

A chain reaction can only start in the presence of a certain amount of fissile material (the so-called critical mass). The critical mass is the smallest amount of nuclear material at which an explosive chain reaction is possible. For uranium-235 (U-235), it is about 1 kg. The formed fission products are nuclei of new chemical elements, most of which are unstable. They immediately begin to decay to form stable isotopes. The chain fission reaction is accompanied by the emission of electromagnetic waves (rays)—infrared, visible, ultraviolet, X-rays, and gamma rays.

Another way to release nuclear energy explosively is to achieve the fusion of some light nuclei into heavier ones. The most typical is the thermonuclear reaction between hydrogen isotopes. Under certain conditions, the nuclei of these isotopes combine into the nucleus of the heavier element helium, releasing a huge amount of nuclear energy (Fig. 2). The reaction is called thermonuclear because it requires a temperature of several tens of millions of degrees

to occur. Only at such a temperature can the repulsive forces of positively charged nuclei be overcome.

An atomic explosion results from the instantaneous release of a huge amount of energy during the chain fission of uranium or plutonium. A hydrogen explosion occurs during the thermonuclear fusion reaction. In both cases, energy is released as a result of the redistribution or recombination of protons and neutrons in the atomic nuclei of the charge, which is why both types of explosions are called nuclear explosions, and the weapons—nuclear weapons.

The power of a nuclear explosion is determined by the total amount of released energy, compared to the energy released during the explosion of an equivalent amount of TNT (TNT equivalent). For example, a nuclear bomb with a TNT equivalent of one thousand tons (1 kiloton, Kt) is called such a nuclear munition, during the explosion of which as much energy is released as would be released during the explosion of one thousand tons of TNT. The bombs dropped on Hiroshima and Nagasaki had a power of approximately 20 Kt. Subsequently, atomic and hydrogen bombs with colossal power, measured in megatons (millions of tons) of TNT equivalent, were developed and produced. For example, the hydrogen bomb detonated by the Americans at Bikini in March 1954 had a power of 12.5 Mt.

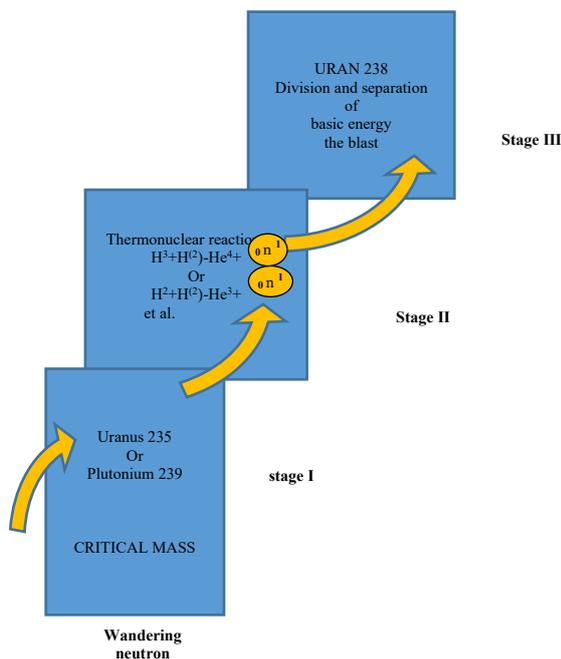


Fig. 2. Scheme of the fusion reaction.

The aim of research is evaluated nuclear weapons – risks in case of their potential use.

II. MATERIALS AND METHODS

Research methods:

- Theoretical methods.

- Mathematical statistical method.

The research results are presented in the work using tables and text [6].

III. RESULTS AND DISCUSSION

The destructive factors differ not only in the nature of their action but also in that they do not affect objects simultaneously and with the same duration. The destructive factors of a nuclear explosion are light radiation, penetrating radiation, shock wave, radioactive contamination of the area, and electromagnetic pulse. [7]

A. Shock wave

The shock wave is the primary destructive factor in the explosion of nuclear munitions. About 50% of the explosion's energy is used to form it.

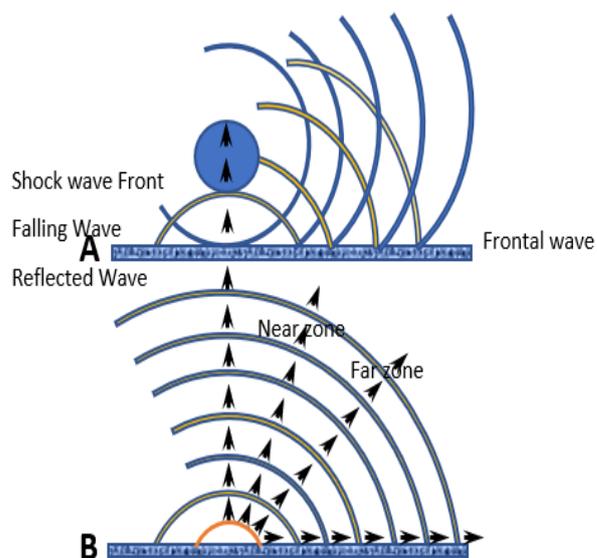


Fig. 3. Diagram of the Formation and Propagation of the Shock Wave (A – Air Explosion; B – Surface Explosion).

The shock wave forms as a result of the pressure created at the explosion's centre, reaching billions of atmospheres. Simultaneously, an enormous amount of thermal energy (millions of degrees) is released. The explosion products strive to expand and compress the surrounding air layers. As a result, the compressed air mass expands and transfers its pressure to adjacent layers. This creates the shock wave—a layer of compressed air, moving at supersonic speed, emanating from the explosion's centre.

The front boundary of the compressed zone, characterized by a sharp increase in pressure, is called the shock wave front (Fig. 3). When the shock wave approaches a point, the pressure and temperature increase instantly, and the air begins to move in the direction of the shock wave. Further, as the shock wave progresses, the

pressure drops below atmospheric, and the air moves in the opposite direction of the shock wave's propagation, i.e., towards the explosion center (Fig. 4). Therefore, following the compression zone, there is a rarefaction zone. Simultaneously, pressure and temperature change. In the compression zone, the temperature rises, and in the rarefaction zone, it decreases.

In an air explosion, the shock wave is spherical. Upon reaching the Earth's surface, it reflects, resulting in a reflected wave with higher pressure than the incident wave. The zone around the explosion's epicentre with a radius smaller than the height is called the near zone.

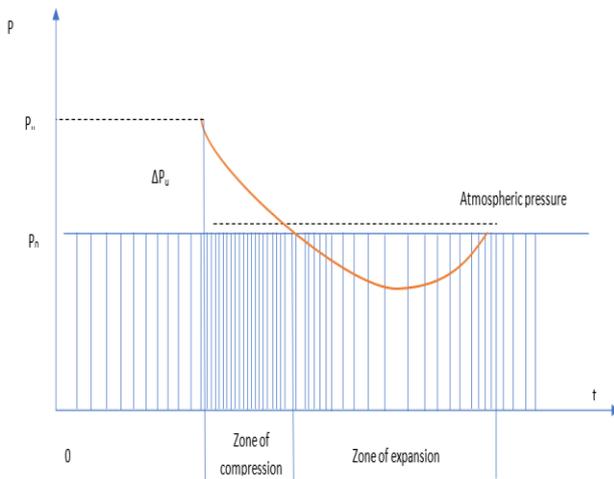


Fig. 4. Pressure Variation Over Time at a Point in the Atmosphere Through Which the Shock Wave Passes.

And with a radius larger than the height of the explosion is distant. In the distant zone, in the ground layer of the atmosphere, the incident and reflected waves merge to form a leading wave.

In a surface explosion, the shock wave propagates through the soil, resulting in transverse and longitudinal seismic waves, and the shock wave does not have a clearly defined front. The propagation speed of the shock wave in this case depends on the soil composition and can be 8-10 m/s. In an underwater explosion, the shock wave mainly propagates in water, with a propagation speed equal to the speed of sound in water—about 1500 m/s.

The destructive effect of the shock wave on humans, animals, plants, and objects is determined by the overpressure in kilograms per square centimetre and the duration of the shock wave's impact. The overpressure varies depending on the distance from the explosion's centre.

Depending on the degree of destruction of buildings and structures, the nuclear impact zone is divided into four areas:

- Zone of complete destruction, covering 13% of the total area of the impact zone.
- Zone of severe destruction—about 10% of the total area.

- Zone of moderate destruction—about 15% of the total area.
- Zone of minor destruction—about 62% of the total area.

TABLE 1 SHOWS THE DISTANCES TO THE OUTER BOUNDARIES OF THE NUCLEAR IMPACT ZONES, DEPENDING ON THE MUNITION'S POWER

Zone	Distance (Km) at different power outputs ammunition (Mt)				
	0,5	1	5	10	20
Complete destruction	3,2	4,0	6,8	8,6	10,7
Strong destruction	4,4	5,4	9,3	11,7	14,7
Medium destruction	5,5	7,0	12,0	15,0	19,0
Weak destruction	9,0	11,1	16,5	20,4	30,8

Heating the soil can cause damage to the base of plants. In such cases, damage begins on the heated side as watery spots, which dry out, expand due to weak parasites, and cause the plants to die (wither). Warm air blowing on leaves and fruits causes them to dry out to varying degrees. Damage is most significant in sparsely planted plants, transplanted seedlings, currants, vines, and other crops.

Light radiation, as a destructive factor of a nuclear explosion, affects agricultural buildings, warehouses, shelters, various structures, etc., to varying degrees, causing fires and thus destroying the agricultural products, equipment, and other items stored in them. The damage to agricultural buildings is expressed in complete burning or only igniting easily flammable parts. The following data provide an idea of the nature of possible fires caused by a medium-caliber nuclear munition:

- Complete burning at a distance of 700-800 m from the explosion's epicentre.
- Complete burning of all brick and wooden buildings, severe burning of reinforced concrete and metal structures—800-1500 m.
- Moderate burning of brick buildings and severe burning of wooden structures—2500-3000 m.
- Slight burning of brick buildings
- Severe burning of wooden structures—3000-4000 m.

These data refer to an air explosion at several hundred meters height (400-500 m above the ground). In a surface atomic explosion, the damage is 10-15% weaker compared to the indicated data. The density of fires depends on the nature of the terrain, the density of construction, and atmospheric conditions.

The distance at which light radiation can ignite agricultural buildings is not very large, as it mainly depends on the duration of its action. Even in the explosion of a

powerful nuclear munition, light radiation has a short-term nature—not more than 2-3 seconds.

From previous atomic weapon tests, it has been found that in populated areas on the periphery of the atomic radius, light radiation causes fires mainly on roofs made of easily flammable materials. Light radiation causes large-scale fires when objects are in flat terrain. If objects are in rugged terrain, even at a short distance from the explosion site, the terrain's folds protect them from light radiation.

In the event of an expected incident, the main measures related to protection from light radiation can be summarized as follows [8]:

- Conducting organizational measures to ensure faster harvesting of ready agricultural products from cereal, forage, technical, perennial, and other crops. When storing coarse fodder, avoid concentrating it in one place and, if possible, do not place it on high points (platforms) of the terrain.
- Providing distribution barrier strips on areas occupied by cereal crops. Strips 15-20 m wide are plowed in areas over 1000 m², with protective strips 80-100 m wide near forest massifs.
- Using various protective materials to reduce the degree of damage (asbestos textiles and asbestos boards to cover ready products, foam generators, fire extinguishers, and other chemical fire inhibitors).

The neutron flux emitted during a nuclear explosion result from the fission chain reaction and the fusion thermonuclear reaction. Neutron fluxes are emitted within a millionth of a second, hence called instantaneous neutrons. Only a small percentage of all emitted neutrons are released by the end of the first minute. Thus, in practice, neutrons are emitted before the bomb vaporizes, having to penetrate the materials it's made of. Interacting with these materials, fast neutrons decelerate, losing part of their energy and beginning to move in a zigzag pattern.

Only 0.025% of the explosion's total energy is used to form neutrons. They move at nearly the speed of light, instantly reaching the biosphere, so in a sudden explosion, there's hardly any benefit to seeking barrier protection (shelter). However, quickly lying on the ground can reduce neutron exposure to the body.

Neutrons emitted during the chain reaction, as we have already learned, are called fission neutrons. They possess high kinetic energy; hence some authors refer to them as fast neutrons. When neutrons collide with atoms' nuclei from the surrounding environment, they lose part of their energy, transforming into intermediate neutrons, and later into slow neutrons when reaching thermal equilibrium with the surroundings (thermal neutrons). These neutrons have the least energy. All described processes of neutron release and deceleration still occur within the reaction zone.

Once neutrons exit the boundaries of the exploding bomb, they weaken again when colliding with atoms and

molecules in the air, dispersing into the surrounding space. They most commonly collide with nitrogen and oxygen nuclei. The energy a neutron transfers upon encountering a nucleus is greater the smaller the atomic number of that nucleus, with oxygen nuclei being relatively light. Upon collision with a nitrogen nucleus, a neutron can be completely absorbed (neutron capture). Neutron capture is accompanied by the release of gamma rays.

Penetrating radiation and secondary radioactivity have harmful biological effects on living organisms. The primary protective measures in agriculture should focus on ensuring the protection of people, animals, and part of the harvested and ready products. Protective measures can be applied in some cultivation facilities if they are not exposed to the effects of the shock wave and light radiation. [9]

Protecting organisms from radiation's harmful effects can be successfully achieved if the mechanism of the radiobiological process is understood. However, no theory currently fully explains all aspects of this complex mechanism. After clarifying the role of free radicals and the theory of radiation's indirect action, the first reports on the protective role of various chemical substances appeared. The degree of damage significantly changes when these chemicals are introduced into the organism before, during, and after irradiation. Numerous scientists successfully use substances containing M-groups, easily oxidized by free water radicals and peroxides formed during irradiation with oxidation of sulfhydryl groups present in free and bound states in the living cell.

The state of the living cell is connected to the indirect action of radiation. The authors suggest that if the damaged (oxidized) sulfhydryl groups in the organism are replaced with new ones (cysteamine, glutathione), the organism will significantly recover. A similar effect is observed with sodium hyposulfide, sodium cyanide, and others.

Protecting against neutrons in a nuclear explosion is much more challenging than protecting against gamma radiation. Dense materials effectively protect against gamma rays by absorbing them more intensively. These same materials are far less effective against neutrons. The best protection against neutrons is provided by substances containing many hydrogen atoms and water molecules. Concrete and soil provide relatively good protection against both neutrons and gamma rays. For example, a 25.4 cm thick concrete layer reduces neutron dose tenfold, and with 50.8 cm—hundredfold. Adding iron pieces or even iron ore to concrete enhances its protective properties not only against gamma rays but also against neutrons. Thus, this "heavy" concrete needs to be only 18 cm thick to reduce the neutron dose tenfold instead of 20.4 cm.

Adding boron and boron compounds to protective material also increases its effective protection since boron isotopes effectively capture slow neutrons. However, this neutron capture releases soft gamma rays (0.48 MeV), which are relatively easier to attenuate when passing through this screen.

Like gamma rays, neutrons undergo scattering when passing through the air. This does not complicate protection since scattered neutrons lose much of their energy with distance and do not significantly increase the cumulative gamma and neutron dose.

B. Radioactive contamination of the area

Radioactive contamination involves the deposition of radioactive substances (radioactive dust) on the area and all objects. The main sources of radioactive contamination are radioactive isotopes formed by the fission of nuclei of substances, secondary radioactivity, and remnants of unreduced parts of the nuclear charge. [10]

In a nuclear explosion, the enormous amount of heat released vaporizes all substances at the explosion site, resulting in a fireball. The vaporized earth mass rises as a radioactive cloud. As the temperature of the fireball decreases, the vaporized substances condense, forming highly radioactive ash. Lifted to a high altitude, it gradually settles, with air currents carrying it far from the explosion's epicentre. Depending on the distance and area where the ash settles, local and general (total) radioactive contamination can be distinguished.

Larger particles settle near the explosion site, forming local contamination. Since they fall first, radioactive isotopes with a short half-life do not have time to decay, resulting in high particle activity primarily consisting of short-lived fission products like radioactive isotopes of molybdenum-99 (Mo99), tellurium-32 (Te32), iodine-131 (I131), barium-140 (Ba140), etc.

When the nuclear charge detonates at a higher altitude, the concentration of radioactive products occurs on condensation nuclei of much smaller size, usually molecules of more refractory metals, and radioactive products remain in atomic form. Therefore, they rise to much higher altitudes (20-30 km) and enter the stratosphere. From there, air currents carry them over vast distances, resulting in general (total) contamination of extensive global areas with relatively low activity. The deposition of radioactive particles from the stratosphere can occur by wet and dry means. Wet deposition occurs through rain and snow, while dry deposition occurs under the radioactive particles' weight.

Radioactive substances elevated into the stratosphere settle over many years, averaging 10% per year. Consequently, explosion products causing general radioactive contamination contain mainly long-lived fission products like strontium-90 (Sr90) and cesium-137 (Cs137).

The contamination level, i.e., the amount of isotopes in the soil within a limited area, will not be uniform. For example, the degree of strontium-90 contamination over an area of 35,000 km²: Along the radioactive cloud path in a nuclear explosion with a yield of 1 Mt, the percentage will be: over 50 Ci/km²—0.594%; from 20 to 50 Ci/km²—2%; from 6 to 20 Ci/km²—6%; from 2 to 6 Ci/km²—14.5%; from 0.6 to 2 Ci/km²—77%. This suggests that much of the territory may be suitable for agricultural production.

Long-lived radioisotopes remain in the upper soil layer (up to 5 cm) for a long time. If the soil is not tilled, strontium-90 is preserved up to 70-80% for 10 years. Plowing redistributes the radioisotopes in the upper layer, where they remain for a long time. The average horizontal displacement of isotopes is about 1% of their quantity in a given area, with highly eroded sites up to 10-15%. The concentration increases in low terrain areas during radioisotope washout.

Long-lived radioisotopes also include cesium-137, cesium-144, ruthenium-106, zirconium-95, etc. The primary contamination threat to plants and plant products is strontium-90. The amount of strontium-90 can be reduced over part of the area by surface scraping the contaminated soil layer using graders, scrapers, bulldozers, etc.

Radioactive contamination of the area is characterized by the radiation dose received from the moment of radioactive substance deposition to their complete decay.

Depending on this, the territory exposed to radioactive contamination can be divided into four zones [7]:

- Zone A—Moderately contaminated zone; the total radiation dose for the far (outer) boundary is 40 R for the near (inner) boundary—400 R
- Zone B—Highly contaminated zone with a radiation dose of 400-1200 R.
- Zone C—Dangerously contaminated zone with a radiation dose of 1200-4000 R.
- Zone D—Extremely dangerous contaminated zone with a radiation dose of 4000-10,000 R.

Each zone is divided into subzones. People, animals, plants, and other living organisms in these radioactive contamination zones will receive a specific radiation dose, resulting in varying degrees of radiation sickness in humans and animals. Plants receiving a certain radiation dose will experience stunted growth and development or die.

C. Electromagnetic pulse (EMP)

In nuclear explosions, powerful electromagnetic pulses (EMPs) are generated, which have a destructive effect on certain types of engineering and communication equipment located in protective structures. The destructive effect of the EMP is observed in objects and connecting lines outside the possible destruction zones. In these zones, the shock wave's effect is stronger.

When clarifying the nature of the EMP, specialists note that the nuclear explosion is accompanied by two types of electromagnetic radiation: one in the form of a powerful short-term pulse, and the other resulting from changes in the electrical properties of the atmosphere due to air ionization and the release of a large number of charged particles. [10] - [12]

In its physical nature, the EMP resembles electromagnetic pulses emitted by lightning or a powerful radio transmitter station.

The powerful EMP can induce electric current in antennas, cables, power lines, and sensitive electrical and radio equipment. As a result, cables and wires may melt, equipment may burn out, and insulation may break down.

The radius of the EMP's destructive effect depends on the type of explosion and the power of the nuclear weapon. According to American specialists, in a low-altitude air explosion with a power of 1 Mt, the destructive radius is 32 km; at 10 Mt, it is 115 km; and at 50 Mt, it is 190 km.

In addition to the direct destructive effect of nuclear explosions caused by the described primary destructive factors, secondary factors of destruction may arise under the influence of the primary factors. These include fires and explosions at chemical and oil refineries, which can cause mass poisoning of people from the release of various toxic substances such as carbon monoxide, ammonia, sulfur dioxide, chlorine, etc. The rupture of dam walls and reinforcement dikes of full-flowing rivers can cause major floods, resulting in the death of people and animals, destruction of ready products, silting of arable land, damage to equipment, and more.

IV. CONCLUSIONS

The study identified several risks of using nuclear weapons:

- The possibility of using nuclear weapons is increasing, as evidenced by the Israeli-Pakistani conflict and the Ukrainian-Russian conflict, where threats of using nuclear weapons are made public.
- Nuclear explosions differ from other bomb/projectile explosions in that only 85% of the energy is expressed as kinetic (thermal) energy, of which 50% is used to create a shock wave and 35% to produce light radiation. This can be explained by the fact that in a chain reaction the temperature rises to tens of millions of degrees.
- Nuclear weapons are one of the most powerful and dangerous types of weapons of mass destruction.
- Heating of the soil can cause damage to the base of plants.
- Damage to agricultural buildings is manifested as complete burning or only ignition of flammable parts.
- In populated areas, light radiation on the periphery of the atomic radius causes fires mainly on roofs made of flammable materials. Light radiation causes large-scale fires if objects are located on flat terrain. If objects are located on uneven terrain, even a short distance from the explosion site, the folds of the terrain protect them from light radiation.
- Penetrating radiation and secondary radioactivity have a harmful biological effect on living

organisms. Primary protection measures in agriculture should be aimed at ensuring the protection of people, animals, and some of the harvested and finished products.

- Larger particles settle near the explosion site, forming local pollution.
- Radioactive substances that rise into the stratosphere settle over many years, on average 10% per year. Consequently, the explosion products that cause general radioactive pollution mainly contain long-lived fission products, such as strontium-90 (Sr90) and cesium-137 (Cs137).
- A strong electromagnetic field (EMF) can induce electric current in antennas, cables, power lines and sensitive electrical and radio equipment. As a result, cables and wires can melt, equipment can burn out and insulation can be damaged.

V. REFERENCES

- [1] S. Stoykov, Scientific knowledge - source of a competitive advantage in security, International conference on High Technology for Sustainable Development HiTECH 2018, DOI: 10.1109/HiTech.2018.8566548
- [2] 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. Vol. IV, 2024*, pp. 83-88. <https://doi.org/10.17770/etr2024vol4.8225>
- [3] S. Stoykov, The system of education, training and research in the field of security - managing change through experience and knowledge, *ETR*, vol. 4, Jun. 2024, pp. 269-274, doi: 10.17770/etr2024vol4.8213.
- [4] N. Dolchinkov, History and development of nuclear weapons, *International scientific journal: Security@future* 1/2018, June 2018, pp. 32-35.
- [5] Schutz vor Massenvernichtungsmitteln. Militärverlag der DDR, 1975.
- [6] Z. Goša, *Statistika*. Rīga: Latvijas Universitāte, 2007.
- [7] A. Dikov, et al. *Nuclear Weapons*. Military Publishing House, Sofia, 1986.
- [8] S. Stoykov, Risk management as a strategic management element in the security system, International Conference on Creative Business for Smart and Sustainable Growth, CreBUS 2019, March 2019, Article number 8840098, Category number CFP19U17-ART; Code 152084, DOI: 10.1109/CREBUS.2019.8840098
- [9] Recommendations for Assessing the Consequences of Radioactive Contamination of Agricultural Areas and Animals, and Management of Agriculture Under These Conditions. Sofia, "Military Publishing House," 1979.
- [10] I. Georgiev, Assessment of the Radiation Situation in Agricultural Objects. Sofia, 1985.
- [11] N.T. Dolchinkov, State of the population disclosure systems in the changing radiation situation in Bulgaria, *Environment. Technology. Resources. Rezekne*, Jun 2019, Latvia. Proceedings of the 12th International Scientific and Practical conference Vol 1, pp. 54-58, ISBN 1691-5402, DOI: 10.17770/etr2019vol1.4152

- [12] L. Poiša, A. Adamovičs, K. Ivanova, and L. Antypova. The significance of bees (*Apis mellifera* L.) in preserving the natural environment. Продовольча безпека України в умовах війни і післявоєнного відновлення: глобальні та національні виміри : тези доповідей учасників міжнародної науково-практичної конференції, м.

Миколаїв, Україна, 30-31 травня 2024 р. /
Міністерство освіти і науки України.
Миколаївський національний аграрний
університет - Миколаїв, 2024, pp. 121-123. DOI:
<https://doi.org/10.31521/978-617-7149-78-0-38>.