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Methods Of Protecting The Population In The Event Of A Radiation Accident

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ABSTRACT: *This article analyzes methods of protecting the population during a radiation accident. Radiation accidents are serious events caused by natural and artificial factors, which pose a threat to public health and the environment. When such accidents occur, a series of effective measures must be implemented to protect the population. This article discusses methods of protecting the population during a radiation accident, including the characteristics of environmental radioactive contamination, radiation safety measures, the use of protective equipment in hazardous areas, and evacuation. Effective methods of protection help mitigate the scale of radiation risks and eliminate their consequences.*

KEYWORDS: *Radiation, accident, population protection, safety, protective equipment, evacuation, radiation level, hazardous areas.*

ANNATASIYA*: Ushbu maqolada radiatsiyaviy avariya sodir bo'lganda aholini muhofazalash usullari taxlil qilingan bo'lib. Radiatsiyaviy avariyalar tabiiy va sun'iy omillar ta'sirida yuzaga keladigan jiddiy hodisalardir, ular aholi salomatligiga va atrof-muhitga xavf soladi. Bunday avariyalar yuzaga kelganda aholini himoya qilish uchun bir qator samarali chora-tadbirlar amalga oshirilishi kerak. Ushbu maqolada, radiatsiyaviy avariya sodir bo'lganda aholini muhofaza qilish usullari, shu jumladan, atrof-muhitning radioaktiv ifloslanish xususiyatlari, radiatsiya xavfsizligi bo'yicha chora-tadbirlar, xavfli hududlarda himoya vositalarini qo'llash va evakuatsiya kabi amaliyotlar ko'rib chiqiladi. Aholini himoya qilishning samarali usullari radiatsiyaviy xavfning ko'lami va uning oqibatlarini bartaraf etishga yordam beradi.*

TAYANCH SO'ZLAR*: Radiatsiya, avariya, aholini himoya qilish, xavfsizlik, himoya vositalari, evakuatsiya, nurlanish darajasi, xavfli hududlar.*

АННОТАЦИЯ: *В данной статье анализируются методы защиты населения при радиационной аварии. Радиоактивные аварии — это серьезные события, возникающие под воздействием природных и искусственных факторов, которые представляют угрозу для здоровья населения и окружающей среды. При таких авариях необходимо принять ряд эффективных мер для защиты населения. В статье рассматриваются методы защиты, включая особенности радиоактивного загрязнения окружающей среды, меры радиационной безопасности, применение средств защиты в опасных зонах и эвакуацию. Эффективные методы защиты помогают минимизировать масштабы радиационной угрозы и ликвидировать её последствия.*

КЛЮЧЕВЫЕ СЛОВА*: « радиация, авария, защита населения, безопасность, средства защиты, эвакуация, уровень радиации, опасные зоны.»*

Introduction.

In today's era of advancing technology, as in all other fields, radioactive equipment and technologies are also widely used in industry. This branch of industry is considered extremely dangerous due to the release of radiation. Radiation is ionizing radiation, that is, energy that spreads in the form of particles or waves, which can alter the structure of atoms and molecules through interaction with materials. This process can be hazardous to life, since high doses of radiation may damage the cells of living organisms, cause mutations, lead to serious illnesses such as cancer, or even result in death. The necessity of protecting the population and workers from radiation hazards arises precisely from the severe impact of these risks.

The danger of radiation is primarily manifested in its different effects on the human body. Cells exposed to ionizing radiation lose their structure and their functions are disrupted. This can lead to extremely serious health problems, including genetic mutations, weakening of the immune system, and the development of cancer. As a result, individuals affected by radiation are not only a threat to their own health but may also endanger future generations.

Radiation accidents can occur at many large nuclear energy facilities, particularly at nuclear power plants. Examples include the Chernobyl disaster (1986), the Fukushima disaster (2011), and other radiation-related catastrophes. These accidents drastically affected not only the environment but also the lives, health, and economic well-being of tens of thousands of people. In the case of Chernobyl, radiation contaminated territories within hundreds of kilometers for many years, forcing the evacuation of residents. The Fukushima accident, on the other hand, caused severe environmental, economic, and public health damage to the Japanese population.

Thus, the importance of protection against radiation hazards is a pressing issue that affects not only individuals but also the global community as a whole. Preventing radiation accidents and mitigating their consequences require effective protective measures, proper planning, and preparedness through modern technologies.

Main Part.

A radiation accident can pose serious threats to both people and the environment. In such cases, it is crucial to implement highly effective measures to protect the population and workers. This article analyzes the main methods of protecting the population in the event of a radiation accident. These methods include detecting radioactive contamination in the environment, ensuring safety in hazardous areas, implementing radiation safety measures, and using protective equipment against radiation sources. In addition, technologies and systems necessary for protecting the population are also considered.

The methods of protecting the population during a radiation accident include:

- Characteristics of radioactive contamination in the environment;
- Ensuring radiation safety measures and analyzing compliance with standards, rules, and hygiene norms in the field of radiation safety;
- Assessing the probability and scale of radiation accidents, as well as the level of preparedness for effectively eliminating accidents and their consequences;
- Analyzing doses of radiation received, being received, and expected to be received by workers and the population from all ionizing radiation sources;
- Determining the number of people exposed to radiation levels exceeding the established basic dose limits.

Radiation safety at a facility and in its surrounding areas is ensured by the following indicators:

- Construction of the radiation facility;
- Rational selection of site and location for the radiation facility;
- Physical protection of radiation sources;
- Zoning of territories inside and around the most hazardous facilities;
- Conditions of technological systems' operation;
- Radiation-hygienic assessment and licensing of activities involving radiation sources;
- Radiation and hygienic assessment of products and technologies;
- Availability of a radiation monitoring system;
- Planning and implementation of measures to ensure radiation safety of workers and the population during normal operation, reconstruction, and decommissioning of a facility;
- Improving radiation and hygienic literacy of workers and the population;
- Restrictions on access to work with radiation sources based on age, gender, health status, previous exposure level, and other indicators;
- Knowledge and compliance with rules for handling radiation sources; adequacy of protective barriers and distance from radiation sources, as well as limiting the duration of work with them;
- Creating working conditions that meet the requirements of NRB-2006 and relevant regulations;
- Use of personal protective equipment;
- Compliance with established reference levels; organization of radiation monitoring;
- Organization of a radiation information system;
- Taking effective protective measures for workers when planning responses to threats and accidents.

Protection of the population against radiation is achieved through the following tasks:

- Timely introduction and application of tools and methods to identify and assess the scale and consequences of accidents at radiation-hazardous facilities;
- Establishment and use of monitoring systems (mainly automated) and local warning systems at hazardous facilities;
- Development and implementation of radiation protection regimes for the population, functional facilities of the economy, and infrastructure in conditions of gas contamination of the area;
- Pre-adaptation of utility services and transport enterprises to carry out special decontamination of clothing, property, and transport in emergency situations;
- Training the entire population to use personal protective equipment and follow the rules of conduct in contaminated areas.

In the event of an accident at nuclear power plants and other nuclear energy facilities, a number of measures must be implemented to protect the population. The scope and nature of these measures depend on the scale of the accident, its phase, and the time elapsed.

Table 1
Protective Measures for the Population during Radiation Accidents

Accident phase and its duration	Source of radiation	Main type of exposure	Protective measures for the population
Initial phase (from a few seconds to several hours)	Radioactive clouds and vapors	Internal and external exposure of organs and tissues	Public warning, protection of respiratory organs and body, evacuation, iodine prophylaxis, personal decontamination, and monitoring of food and water products
Intermediate phase (from several days to up to one year)	Radioactive substances and radioactive cloud	Internal and external exposure of organs and tissues	Relocation of the population, environmental decontamination, monitoring of food and water products, and establishment of medical supervision

When radioactive substances settle on the ground, dust formation can occur in many ways (strong winds, movement of vehicles—especially on dirt roads, agricultural activities). In such contaminated areas, the use of respiratory protective equipment is extremely important.

A large amount of radioactive substances falling onto exposed areas of the skin can cause skin damage and burns. To prevent such harm, protective gear such as raincoats, vests, coveralls, rubber boots, and gloves should be used.

The protective properties of ordinary clothing can be enhanced to make it airtight: for example, by using additional layers, tightening with flaps, or impregnating the fabric with an emulsion mixture (2 liters of hot water, 250–300 g of grated soap, and 0.5 liters of mineral or vegetable oil).

Figure 1. Protection against radiation using clothing

Requirements for Limiting Radiation Exposure in the Event of a Radiation Accident. In the event of a radiation accident, it is necessary to establish control over the radiation source and take practical measures to minimize the radiation dose, the number of people exposed, the radioactive contamination of the environment, and the resulting economic and social losses.

When a radiation accident or radioactive contamination is detected, protective measures begin with minimizing the impact on the environment and protecting the population. If, within a short time (2 days), the expected radiation dose rises to a high level, deterministic effects of higher severity may occur. In this case, urgent intervention (protective measures) is required. (Table 2).

Table 2

Absorbed Dose Levels Requiring Urgent Measures

Organ or tissue	Absorbed dose over 2 days (Gy)
Whole body	1
Lungs	6
Skin	3
Thyroid gland	5
Eye lens	2
Gonads	3
Fetus	0.1

In cases of chronic exposure during life, if the annual absorbed doses exceed the values given in Table 2, protective measures become mandatory. Exceeding these doses leads to serious deterministic effects.

The intervention levels for temporary relocation of the population are as follows:

- To begin temporary relocation: **30 mSv per month**;
- To end temporary relocation: **10 mSv per month**.

If it is estimated that the accumulated dose within one month will exceed the annual specified level, the issue of resettling the population for permanent residence must be resolved.

When implementing radiation protection interventions, dose limits are not applied (see Table 1). In the event of a radiation incident, the planning of protective measures is carried out under the supervision of the state sanitary-epidemiological authority. The intervention level (dose and dose rates, radioactive contamination level) is established for a specific radiation facility and its location conditions, taking into account the probable types of accidents, possible emergency development scenarios, and the existing radiological situation. In such cases, the radiation levels indicated in Table 3 may be disregarded.

In the case of accidents that cause large-scale radioactive contamination of a territory, a radiation accident zone is established based on monitoring and forecasting of the radiological situation.

When a large radiation accident occurs with contamination of the territory, decisions on protective measures for the population are made by comparing the predicted dose averted by protection and the contamination level with Levels A and B given in the table.

If the exposure prevented by a protective measure exceeds **Level A** but does not reach **Level B**, the decision to implement protective measures is made based on justification and optimization principles, taking into account the specific situation and local conditions.

If the exposure prevented by a protective measure reaches or exceeds **Level B**, the corresponding protective measures must be implemented, even if they disrupt the normal life of the population or the economic and social activities of the area. In the later stages of a radiation accident that causes contamination of large territories with long-lived radionuclides, decisions on protective measures are made considering the current radiation situation and specific socio-economic conditions.

One of the important preventive medical measures to reduce internal radiation doses, especially in the second stage of the accident, is the radiometric monitoring of radionuclide levels in food products produced from locally sourced raw materials. Such monitoring is carried out by specialized laboratories.

Conclusion

Radiation accidents are natural or man-made events that pose serious threats to human health. Ionizing radiation negatively affects the environment and living organisms, and high doses of radiation can alter cellular structures, cause mutations, and lead to cancer. Radiation accidents can occur, particularly at nuclear energy facilities or during the use of nuclear weapons, resulting in widespread contamination and posing significant risks to public health. Understanding how radiation affects the human body is crucial for effectively protecting the population.

Radiation can enter the human body through various pathways and damage its cells. Ionizing radiation can harm DNA and trigger genetic changes, leading to cancer, blood and circulatory system disorders, immune system weakening, and other serious illnesses. Prolonged exposure to radiation is especially hazardous, and the highest levels of radiation can cause critical biological changes and even death. Therefore, developing effective protection methods to minimize radiation risk is essential.

There are several key methods for radiation protection. First, the use of protective equipment is necessary. Maintaining distance from radiation sources, blocking radiation with protective materials (such as lead or concrete), and wearing specialized protective clothing (radiation suits, respirators) play a vital role in safeguarding against radiation hazards. Second, evacuation and rapid removal from hazardous areas are of great importance. By relocating the population and workers to safe areas, exposure to high radiation doses can be prevented. Effective control must be ensured through careful planning, automated systems, and warning systems.

Another method of radiation protection is implementing radical preventive measures, such as isolating affected individuals, continuously monitoring their health, and providing prompt medical assistance if necessary. Increasing the population's literacy on radiation safety also plays a key role in protecting against radiation hazards. Therefore, ensuring radiation safety requires not only technological measures but also social education and awareness.

Preventing radiation hazards and mitigating their consequences requires a broad and comprehensive approach. Implementing all protective measures effectively helps reduce the impact of radiation hazards. Radiation safety involves taking all necessary actions to protect the human body from high-dose radiation and prevent its long-term adverse effects.

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