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## EMERGENCY RESPONSE DURING ELIMINATION OF CONSEQUENCES OF RADIATION ACCIDENT: HISTORY AND MODERNITY[1]

*The article focuses on issues that are important for timely emergency response when eliminating the consequences of a radiation accident at a nuclear power plant and more effective safety in the event of man-made emergencies. The author's interpretation of issues related to the operation of modern nuclear power plants and a retrospective view of the "Japanese Chernobyl," made it possible to update the prospects for the safe development of the nuclear industry in the modern Republic of Belarus.*

***Keywords:*** *nuclear energy, Fukushima-1, safety at high-risk facilities, emergency response in eliminating the consequences of a radiation accident.*

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## АВАРИЙНОЕ РЕАГИРОВАНИЕ ПРИ ЛИКВИДАЦИИ ПОСЛЕДСТВИЙ РАДИАЦИОННОЙ АВАРИИ: ИСТОРИЯ И СОВРЕМЕННОСТЬ

*В статье сделан акцент на вопросах, которые важны для своевременного аварийного реагирования при ликвидации последствий радиационной аварии на атомной электростанции и более эффективного обеспечения безопасности в случае возникновения чрезвычайных ситуаций техногенного характера. Авторская интерпретация вопросов, связанная с эксплуатацией современных атомных электростанций и ретроспективным взглядом на «японский Чернобыль», позволила актуализировать перспективы безопасного развития атомной отрасли в современной Республике Беларусь.*

***Ключевые слова:*** *атомная энергетика, «Фукусима-1», безопасность на объектах повышенной опасности, аварийное реагирование при ликвидации последствий радиационной аварии.*

[1] Статья публикуется в авторской редакции.

Introduction. Economic and economic global systems are associated with the operation of modern nuclear power plants, where, as practice shows, sometimes emergencies of a man-made nature arise. Thus, the events with the "Japanese Chernobyl" actualize issues related to the occurrence of man-made emergencies and emergency response during the elimination of the consequences of a radiation accident at a nuclear power plant, which is directly related to ensuring the national security of the Republic of Belarus in the context of the development trends of the modern world [1, p. 52].

Along with geopolitical changes taking place on the territory of modern Ukraine, as well as in a situation of growing international turbulence, emergencies inevitably arise regarding the operation of nuclear power plants, due to the fact that the strategic rivalry of the powerful has every chance of moving into another more alarming phase [2, p. 6]. Therefore, it is now important to pay special attention to the safety of nuclear power facilities, which, in many respects, determine the economic stability and sustainable development of society. It is necessary to take into account the fact that due to its geopolitical position and the openness of the national economy, our country is exposed to all the processes of world globalization. And in such geopolitical conditions, taking into account the sanctions pressure, the issue of creating a new model of regional economic cooperation is acute for Belarus, aimed primarily at interaction with regional integration associations: the EAEU, BRICS, ASEAN, SCO and the OPOP initiative created by China [3, p. 51]. Unfortunately, in the process of the growing confrontation of the world "centers of power," the number of natural and man-made disasters affecting the biosphere, technosphere and sociosphere does not decrease, which increases the risks associated with the environment and the development of natural and economic systems, the safe operation of nuclear power plants [4, p. 195].

Relevance and author's novelty is determined by the fact that in the event of a radiation impact on economic facilities (in the event of an emergency at a nuclear power plant), changes occur that lead to pollution of the territory, changes in the natural environment (high level of radiation), having a devastating effect on human health and the biosphere. It should also be borne in mind that the ongoing global and regional changes, which, as practice shows, are related to destructive geopolitical transformations, especially in the event of an emergency at a nuclear power plant. The problems of environmental protection and active cooperation of the BRICS countries in the field of nuclear, electrical industry, as well as technological modernization of the energy sector, are becoming especially relevant today due to the emphasis on the practical justification of the development of the energy complex in the context of the global transformation of the structure of public production and the prospects for the development of environmentally friendly, resource-saving energy in the territory of the modern Republic of Belarus.

And if earlier, scientists, experts focused only on energy efficiency, today, it is possible and necessary to update the entire range of economic, environmental, socio-political measures to reasonably increase the nuclear industry, which requires rethinking approaches to the production and consumption of energy by mankind. According to experts in the field of the fuel and energy complex, attention should now be paid to the development of nuclear energy for the long term, which especially actualizes two components: the limited resources of natural uranium and the high level of radioactivity in the fuel cycle when new fuel appears [5, p. 60]. Any modern station must have temporary storage of spent nuclear fuel with subsequent transportation, which involves the construction of special enterprises for the storage and processing of radioactive waste, requiring the use of geoinformation situational modeling focused on the study of changing operating conditions of technical systems, especially during emergency response, elimination of the consequences of a radiation accident at a nuclear power plant. Timely safety measures directly relate to the operation of nuclear power plants, since the radiation hazard today is represented by waste from nuclear technologies, active spent fuel (processing and production of uranium hexofluoride, nuclear fuel in storage facilities, etc.). Apparently, at the present stage it is important to reduce the cost of technologies for the production and consumption of electricity, improve the safety and reliability of nuclear power plants, focusing on the efficiency of energy systems, on expanding the availability of energy using the

most advanced information technologies, which actualizes issues related to emergency response in eliminating the consequences of a radiation accident [6, p. 140].

**Main part.** The world practice of recent decades confirms that in a multipolar world there are man-made accidents that provoke physical, chemical and biological impact, radiation pollution of nature, man, which is directly related to emergency response when eliminating the consequences of a radiation accident at a nuclear power plant in case of emergencies.

So, today everyone understands that rare accidents on the power systems of nuclear power plants are very dangerous, most often, lead to an environmental disaster. So, historical facts indicate that in 1986 there was a terrible accident in Chernobyl (USSR), which provoked radioactive pollution of the territories of Europe, Belarus, Ukraine and Russia. It is also known that in 2011 in Japan at the Fukushitma-1 station as a result of a very strong earthquake that caused a tsunami, a natural and man-made disaster occurred, destroying four units of a nuclear power plant. And the so-called "Great Earthquake of Eastern Japan," which occurred in the waters of the Pacific Ocean northeast of Tokyo, provoked the emergence of a tsunami 40 meters high and an accident that resulted in the melting of the reactor core at the three power units of the Fukushima-1 nuclear power plant. In such an emergency, the station's systems received an earthquake signal and automatically shut down the nuclear reactors, starting emergency cooling systems. But, the impending tsunami wave overcame the barrier, flooding the station and damaging the cooling systems, which led to the melting of nuclear fuel in the reactors of the power units, and the accumulated hydrogen led to explosions, releasing a huge amount of radiation into the atmosphere.

During the liquidation of the consequences of the radiation accident at Fukushima-1, the population was urgently evacuated from the three-kilometer zone around the nuclear power plant, and four days later the evacuation zone of 164 thousand people was 20 kilometers [7]. The International Atomic Energy Agency noted that the speed of evacuation has become an important factor in the minimum number of victims in the aftermath of a radiation accident in Japan. Employees of the Fukushima-1 nuclear power plant were urgently hospitalized, but radiation poisoned water, soil and more than 160 thousand people were evacuated during the elimination of the consequences of a radiation accident.

Also, an increased content of radionuclides was found in food not only in Fukushima Prefecture itself and in remote areas of the country. And although no one died from radiation, but, in subsequent years, many people died from exacerbation of chronic diseases and nervous shock. "Japanese Chernobyl" destroyed the city of Yamada, Iwate Prefecture, the settlements of Minamisanriku, Sendai, Okuma on the east coast, where the station was located, were seriously damaged. After this tragedy, which, according to experts, is inferior to Chernobyl in terms of the scale of the consequences, the Japanese catastrophe became the worst accident at a nuclear power plant in the history of mankind.

The emphasis on emergency response in eliminating the consequences of a radiation accident at a modern nuclear power plant, in the event of a man-made emergency, is primarily associated with minimizing risks, hazards and ensuring the safety of the facility. An emergency situation that may arise at a modern nuclear power plant is predicted by rescue firefighters, which, on the one hand, is a practical activity, and on the other hand, in the process of emergency response during the elimination of the consequences of a radiation accident, has a social character [8, p. 194].

The main tools for observing changes in indicators in an emergency are various models (information, mathematical, simulation, geographical). Effective tools for observing changes in indicators are various models, which are recreations in the process of mental activity of a person, as an original mental projection of objects (photographs, drawings, paintings, diagrams, graphs, diagrams, geographical maps) [9, c. 66]. And all changes in the state of power systems, as a rule, are recorded on the basis of integral indicators, which occupy an important place in assessing the state of the environment and determining the level of radiation safety [10, p. 195].

**Conclusion.** So, historical facts indicate the importance of improving management methods and forms of training of personnel (rescuers-firefighters) at a nuclear power plant, necessary in the event of an emergency response to eliminate the consequences of a radiation accident [11, c. 116]. The socio-economic dynamics of

the past twenty years have demonstrated a wide range of destructive geopolitical and environmental transformations affecting the global energy system. Innovative technological trends, innovative global trends, as practice shows, call into question the established approaches to the development of energy systems in the context of global destabilization and the situation on the territory of modern Ukraine.

And if we recall the man-made accident at the Japanese nuclear power plant, which, according to the International Classification of Nuclear Events, belongs to the highest level of seven possible, then it is clear to everyone that this is due to environmental protection, the search for alternative energy, professional and timely emergency response of rescue firefighters when eliminating the consequences of a radiation accident at a nuclear power plant. I will clarify that in the coming decades, due to three damaged Fukushima-1 power units, repair work is not being carried out in full, which negatively affects human health and the environment. According to experts, radioactive water is gradually purified, which is pumped into tanks, where it accumulates and is discharged into the ocean, having a radiological effect on humans and nature, polluting the water area of this region, which does not at all contribute to environmental protection and the promotion of environmentally friendly and energy-saving technologies [12, p. 188].

Accidents that occur, both due to human fault and due to natural and man-made nature, are accompanied by radiation pollution of the environment, since the nuclear power plant, where radioactive waste of spent nuclear fuel is stored, is a source of ionizing radiation from nuclear submarines that pollutes the biosphere of our planet. But, at the same time, the prospects for the development of global nuclear energy prove that, despite the danger in the event of man-made emergencies, it is not possible to localize the construction of nuclear power plants, since humanity consumes more and more electricity every year. Along with this, firstly, it is necessary to focus the efforts of engineers on creating strong layered protection, focused on a system of barriers along the path of the spread of radioactive substances, ionizing radiation, as well as on the implementation of organizational and technical measures to protect the population, station personnel in the event of a crisis situation (protection against probable personnel errors, failures of the equipment used at the station).

Secondly, in the near future, it is more efficient to carry out emergency rescue operations and organize financing of material and technical services in the event of a radiation accident at a nuclear power plant during the elimination of the consequences of a radiation accident for the subsequent restoration of infected areas.

And, thirdly, it is necessary to focus on international cooperation and comprehensively develop:

1) creation of a database on radiation accidents, natural disasters, man-made disasters occurring in the world;

2) the use in the modeling process of neural network, statistical, logical-probabilistic methods developed on the basis of statistics of natural, man-made disasters,

3) sensing of territories, polluted environment and algorithmization of the database using geoinformation Internet technologies in order to optimize compensation for environmental damage caused by an emergency situation at a nuclear power plant [13, p. 73].

In connection with the above, I will clarify that the area of activity of engineers should be situational modeling, which is directly related to emergency response when eliminating the consequences of a radiation accident at a modern nuclear power plant, in the event of man-made emergencies. A retrospective look at the so-called "Japanese Chernobyl" allowed the author to clarify the problem field and more clearly outline the prospects for the safe development of the national nuclear industry.

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