

ANALYSIS OF RADIOLOGICAL INDICATORS IN THE PROCESS OF ENVIRONMENTAL CERTIFICATION OF THE CHORNOBYL EXCLUSION ZONE TERRITORY

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Received: 4.09.2018

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Abstract. The problematic issue of environmental certification of radiation hazardous objects that needs to be solved for substantial improvement of the situation in the field of environmental protection, preservation and restoration of natural systems and ecosystems is worked out.

The purpose of the development of the environmental passport of the Chornobyl Exclusion Zone (CEZ) territory is defined. The requirements and recommendations for the structure and content of the environmental passport of the CEZ are provided.

Key words: environmental passport, radiation hazardous object, environment protection, natural resources

1. Introduction

After the accident at the 4th power unit of the Chernobyl Nuclear Power Plant, a zone of radioactive contamination appeared. At the initial stage it was defined as a 30-kilometer zone. Radioactive emissions from the destroyed reactor caused the emergence of such separate Ukrainian ecological problem as the exclusion zone. It is a highly polluted area formed around the destroyed power unit and the station itself and which is being under the influence of increased radiation exposure over a significant period of time. This zone creates significant issues for the country, as it is a large (2598 km²) and permanent source of radionuclides for the regions adjacent to it. During all the years after the accident, it was and still remains the subject of careful attention of researchers specializing in different areas of knowledge, in particular, radiobiologists and radioecologists, as a unique scientific area. At the legislative level, the registration of the zone status began in 1991,

when the law of the Ukrainian SSR "On the Legal Status of the Territory Exposed to the Radioactive Contamination Resulting from the ChNPP Accident" was adopted (February 27, 1991), amendments and additions to which were made repeatedly [1]. As a result, a zoning system was developed which identified 4 zones according to the level of contamination. The most contaminated of them is the exclusion zone. It is the territory from which people were evacuated in 1986.

Initial attempts to create an ecological passport for the Chornobyl Exclusion Zone (CEZ) were initiated by the Ministry of Environmental Protection and took place in the 90's of the twentieth century. But, due to the lack of financial support and imperfect legislative framework, the environmental passport draft was "put to pause" [2]. However, recently, there appeared a tendency in Ukrainian politics to integration into Europe (and, as a consequence, environmentalization of production), which has made it possible to resume research on environmental certification.

2. Basic theoretical part

Environmental passport is a document that is made with the purpose of ensuring the governmental registration of the objects that have a harmful effect on the environment, control over the environmental safety, prevention and elimination of the negative impact on economic and other types of activities.

Environmental passport [3] is a standard legal document containing detailed information about the location, functions, characteristics of the object, the degree of use of natural and other resources, their impact on the main components of the environment; the document in which specificity and dynamics of the

environmental problem development are registered and which contains the information that is necessary for effective solution of environmental issues. However, creation of an environmental passport of the CEZ territory, new scientific methodological principles and practical developments are needed.

The aims of the environmental passport development for the CEZ territory are the following:

- to ensure the registration of a specific radiation hazardous object (RHO), which has a harmful impact on the environment;
- control over the environmental safety as well as prevention and elimination of the negative influence of radiation on economic and other activities;
- assessment of the negative influence of a particular RHO in the Zone on the environment and determination of the fee for nature use;
- establishment of maximum acceptable radiation-hazardous loads and other environmental indicators for each RHO;
- planning environmental measures for each RHO and assessment of their effectiveness;
- increasing efficiency of natural resources use;
- control over each RHO in accordance with current environmental legislation, environmental norms and standards [4-6].

Radiation hazard object is an object at which one or more hazardous radiation substances, sources of ionizing radiation and radioactive waste are used, processed, stored, or transported, and according to the Law of Ukraine “On the Use of Nuclear Energy and Radiation Safety” constitute a real radiation threat in the case of the anthropogenic or natural emergency.

By association with the structure of IAEA standards, the following classification of RHOs and activities can be offered [7–10]:

- 1–3 power units of the Chernobyl Nuclear Power Plant that were placed out of service;
- “Shelter” object;
- sources of ionizing emission;
- transportation of radioactive materials;
- radioactive waste (RAW) management;
- physical security of nuclear facilities and nuclear materials;
- emergency preparedness and response;
- radiological protection.

On the CEZ territory, on the “Vector” site, there is a facility for long-term storage of RAW with a long decay period. It is planned to carry out simultaneously construction, operation, decommissioning (closing) of RAW processing, storing and dumping objects.

The infrastructure for handling radioactive waste and spent nuclear fuel (SNF) is being developed on the Chernobyl Nuclear Power Plant site. With the active

support of international funds and organizations, liquid and dry RAW recycling plants are built and a “dry” storage facility for spent nuclear fuel (SVYaP-2) is in the process of construction.

In 2017 the total amount of RAW in the CEZ (without the “Shelter” object) was about 2.8 million m³. More than 2.0 million m³ of this radioactive waste is kept in the burial facility for radioactive agents and in the RAW temporal locality with total activity of about 7.4×10^{15} Bq. The total activity of radioactive substances in natural objects of the CEZ (in the surface layer of the soil, bottom sediments of reservoirs, vegetation, etc.) is more than 8.5×10^{15} Bq. The total amount of radioactive contaminated material concentrated in the CEZ reaches 11 million m³. The RAW of Chernobyl origin is extremely diverse in terms of radionuclide composition, levels of specific activity and material composition. Unlike other technological types, radionuclides of Chernobyl origin are characterized by the presence of a wide range of radionuclides (including those with significant periods of half-life).

The generally accepted international principles of ensuring the security of the CEZ territory can be formulated as follows [11]:

1. Ensuring an acceptable level of human health protection;
2. Protection of human health beyond national boundaries should be not lower than an acceptable level in the country of origin;
3. Ensuring the environment protection;
4. Restricting environmental impacts for future generations;
5. Creation of national legal systems and strategies for environmentally safe management of SNF and RAW;
6. Use of an integrated approach taking into account the interrelation of the stages of radioactive waste formation and management.

The following tasks are set in the process of environmental passport creation for the CEZ territory:

- creation of the state accounting and monitoring system for control over the condition of economic entities;
- application a single information document in the state ecological management system for all economic entities, regardless of the form of ownership, for displaying the types of harmful influence of an entity on natural resources and assessment of their comprehensive environmental impact;
- creation of an informational base for assessment of the environmental friendliness of technologies used in production;
- provision of an information basis for licensing nature use;

- provision of an information basis for the introduction of economic mechanisms for stimulating the activities of enterprises in the direction of environmentalization of used technologies, saving natural resources and energy.

The environmental passport of the CEZ territory should consist of 6 sections [3]: General Information, Physical and Geographical Characteristics, Natural Conditions, Ecological Status, Factors of Balanced Development, Suggestions for Nature Protection and Rational Use.

1. General Information.

This section proposes to consider such issues as the area and nature of the CEZ territory configuration; the name of the RHO; a general layout map; a brief description of the RHO, subordination, postal address and details of the enterprise or the owner of the RHO.

2. Physical and Geographical Characteristics.

This section is intended to include information about the radio-ecological state of the territory of the CEZ. It will be developed based on the materials of radiological, hydro-ecological, forest-ecological, biological, toxicological, agro-physical, agro-chemical, phyto-biotic, microbiological, phyto-virological, population-genetic, sanitary-hygienic and socio-environmental monitoring.

At this stage, with the support of operative ecological monitoring the following tasks are carried out:

- assessment of radio-ecological state: density of radioactive contamination, content of mobile forms of heavy metals, etc.;
- assessment of erosion manifestations intensity – development of water linear and plane erosion, deflation and occurrence of dust storms;
- water regime of the reservoir-cooler;
- assessment of physical and chemical state of the soil – salt and water pH, hydrolytic acidity, degree of cation exchange, degree of saturation with basics.

The placement of the CEZ territory in the system of physical and geographical zoning should be included to this section as well.

3. Natural Conditions.

In this section, it is recommended to provide characteristics of natural conditions and resources: meteorological conditions, hydrological conditions, characteristics of soil and vegetation cover.

4. Ecological Status.

This section includes sources, volumes and types of contamination of the CEZ territory based on the integrated environmental monitoring; comprehensive environmental safety of the RHO; radiation safety; forecasting and elimination of ecological situations emergency, recommendations as for raising the level of radiation and ecological safety.

The system of environmental safety of the CEZ territory is heterogeneous, which means that it has elements of the most diverse kind, such as RHO, technical protection systems, people and organizations involved before, during and after the accident at the ChNPP Unit 4, a system of normative and legal requirements etc. The system of environmental safety of the CEZ territory also has its own structuring which can be seen in different interconnections between its elements. This structuring is the one which creates the whole environmental safety system integration. The upgrade of the environmental safety level of the CEZ territory should be considered as a system possessing constant, dynamic and synthetic characteristics [12, 13].

Among constant characteristics, the following can be defined:

- integration;
- permeability;
- inner heterogeneity of the system;
- structuring.

The notion of constant characteristics is used to define the specific states of the system at any recorded moment of time. An integration of environmental safety system, being one of the constant characteristics, means that environmental safety system of the CEZ territory should be considered as an integral unit which is different from other systems, including the safety ones. The system permeability means its cooperation with other systems or environment with the help of inputs and outputs. Considering the environmental safety system of the CEZ territory, these are different inputs as for the RHO use or legal enactments affecting their condition and outputs in the form of environmental impact.

In addition to static characteristics, the environmental safety system of the CEZ territory also has dynamic properties, i.e. such properties which change with time and in connection with other variables.

The dynamical characteristics of this system include:

- functionality;
- ability to be stimulated;
- system changing with time;
- existence in a changing environment.

The following characteristics can be defined as synthetic:

- emergence;
- indivisibility;
- inherency;
- expedience.

Emergence means that the properties of a system cannot be explained through individual elements having their own properties. Emergence manifests itself in the environmental safety system like no other characteristics. Indivisibility of the environmental safety

system of the CEZ territory means that during implementation of its separate parts, the system as such will not exist: it can appear to be different or will insufficiently serve the aim of environmental safety.

The notion of inherency means the system adjustment to the environment. The RHO environmental safety system may and should be created in such a way that it would be quite invulnerable in other force majeure circumstances, such as permanent lack of electricity supply or the earthquake. These important characteristics are connected with the so-called system homeostat. It means the system ability to maintain the constancy of its state through coordinated reactions aimed at maintaining dynamic equilibrium.

5. Factors of Balanced Development.

Social and economic conditions: general social and economic characteristic; the number of the staff living on the CEZ territory, their employment; the level of radiation and ecological education and safety culture.

Environmental conditions are conditions during labour activity, establishment of norms, environmentalization of nature use, ecological management.

6. Suggestions for Nature Protection and Rational Use.

Making suggestions for rational use of nature and protection of the CEZ territory.

At the end of the passport, the information about the performer, the date of environmental passport drafting and the term of its validity are given. The environmental passport is valid for 5 years.

Conclusions

Ecological certification of the CEZ territory will allow solving various kinds of issues connected with environmental protection, preservation and restoration of natural complexes and ecosystems.

Creation of environmental passport of the CEZ territory will make it possible to:

- assess the level of anthropogenic influences of the RHO on the CEZ clearly and in time;
- conduct the environmental influence assessment of the emission and dumping levels of the production process at the RHO;
- support conducting the environmental inspections;
- determine the responsibility for non-compliance with the established legal norms dealing with the issues of nature use.

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