

## ANNOTATION

**to the dissertation work for the degree of Doctor of PhD in the specialty 6D073100-"Life safety and environmental protection" on the thesis "Assessment of the impact of energy facilities on the environment and the development of a remote monitoring system on the example of the city of Shymkent"**

**The basis** for conducting an environmental assessment and in assessing the level of electromagnetic pollution in residential areas was the prediction and predestination of environmental, carcinogenic risks with the recording of the necessary data on the impact of EMF on the environment in static and dynamic mode.

**The initial data** for the research were the results obtained in assessing the intensity level of the distribution of electric and magnetic fields in 110 and 220 kV power lines.

The rationale for the need for scientific research work was the development of thematic environmental maps describing the effects of EMF on the population, as well as the creation of optimal routes in the distribution of electric energy along power lines with subsequent reductions in electromagnetic pollution.

**Information about the planned scientific and technical level of development.** Development of geo-data maps that determine the impact of EMF on the environment and the construction of two-dimensional and three-dimensional characteristics based on the results of the study, allowing for the ranking of EMF hazard gradients.

**The relevance of the problem** The development of information support for environmental problems of the territory on the basis of GIS technologies allows you to record information about the ecological state of the territory at a specific time and represent this state with a set of thematic ecological maps of various territorial or district formations. It should be noted that the above characteristics increase the advantage of geodata technologies as an information database platform that will allow obtaining data for processing operational analyses and conclusions about the state of the environment around high-voltage power transmission lines.

The growing demand of the city of Shymkent for energy has led to the construction and introduction of new energy nodes, high-voltage power transmission lines, which are being built and conducted around residential areas exposed to environmental and carcinogenic risks. In turn, during the construction of new energy facilities, energy companies and designers must submit a cartography of residential areas in the project, in addition to the characteristics of the selected territories and population, which becomes a multifactorial object and subject of research when taking into account environmental and sanitary-epidemiological requirements, as well as when choosing optimal solutions in terms of laying high-voltage power lines. In our case, the Nursat microdistrict, Nazarbayev Avenue and Kazygurt were chosen as such objects, which are polluted residential areas from the point of view of the spread of electromagnetic radiation

generated by 110 and 220 kV high-voltage power lines. The introduction of modern information technologies of a new generation made it possible to accurately determine the main zones of electromagnetic radiation pollution, to establish gradients of electric and magnetic fields depending on the degree of its impact, as well as to determine the number of residential facilities partially exposed to carcinogenic and environmental risk using the functionality of the geodata program.

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**Information about metrological support of research.** The thesis is based on the official terminology of the International Organization of Legal Metrology. In the process of conducting monitoring studies, geodata programs that have passed state verification during operation have been used, ensuring that the accuracy class corresponding to the research and engineering goals in accordance with the "Law on Ensuring the Uniformity of Measurements". In monitoring studies, measurement methods were used that comply with the "Law on Ensuring the Uniformity of Measurements". In functional and graphical dependencies, units of measurement corresponding to the SI system are used.

**The objective of the study:** to identify the degree of carcinogenic risks of the electromagnetic field produced by high-voltage lines with a voltage of 110 and 220 kV by performing basic calculations. As a result of the analytical calculations obtained, the improvement and application of the methodology for substantiating the establishment and expansion of sanitary protection zones for the population and for line personnel exposed daily to carcinogenic environmental risk from high-voltage power lines, taking into account technological, climatic and landscape disturbances.

**The tasks of the study:**

- analysis of key problems regarding the introduction of new scientific results aimed at improving the methodology of environmental expertise for assessing the electromagnetic environment of residential ecological zones;

- local environmental monitoring in places where there is an impact of electric and magnetic fields on the residential ecological zone;
- studies of the necessary geometric parameters of high-voltage power transmission lines by ground-based laser scanning;
- analytical calculation to determine the level of the electromagnetic field by the mirror image method, based on this, to establish the main gradients in the propagation of electromagnetic pollution by the degree of its impact;
- to develop a sanitary protection zone taking into account epidemiological requirements during the construction and commissioning of new low-frequency energy facilities;
- creation of thematic ecological maps on the state of the environment with the addition of visual data on background changes in electromagnetic radiation.

**The relationship of work with scientific programs:**

The dissertation work was performed at the chair "Life safety and environmental Protection" of the South Kazakhstan University named after M. Auezov. The dissertation work is one of the 7 priority directions for the development of Science: "Information, Telecommunications and space technologies, scientific research in the field of Natural Sciences".

**The main idea of the study** is to obtain the necessary conclusions and recommendations to reduce the active impact of the electromagnetic field on residential ecological zones. In turn, this is achieved by optimizing the routes of high-voltage transmission lines relative to residential ecological zones, which allows to limit the radiation zone the population and line workers are exposed to.

**Research methods.** During the research work, the following methods were used: methods of mathematical modeling, methods of spatial modeling of the environment based on geometric (vector) representation of data, methods of spatial-oriented mathematical analysis of digital spatially coordinated data, methods of mathematical interpolation.

**Objects of research.** The object of the study is low-frequency energy facilities, namely 110 and 220 kV high-voltage power transmission lines that generate electromagnetic radiation with carcinogenic risks to the environment.

**The subject of the study are:**

- the limits of applicability of mathematical modeling of electromagnetic pollution propagation in an urbanized environment;
- methods of modeling spatial objects based on geodata systems;
- methods of transformation and structuring of metric-semantic information about space and spatial objects;

**The scientific novelty of the research** is the differentiation of gradients by the degree of danger of electric and magnetic fields arising from high-voltage networks, as well as the creation of new protection zones of electric networks, taking into account the dynamics of changes in EMF:

- when assessing the level of the electromagnetic field, which has its own carcinogenic risks and leads to the expansion of electromagnetic pollution on the example of specific objects, the main external factors were identified;

- Modern information platform of the new generation Esri ArcGIS a methodology has been developed that, in turn, will determine in advance the main environmental risks around low-frequency energy facilities in the environment of residential areas and will develop the necessary recommendations for reducing the electromagnetic field based on information environmental analysis;

- new sanitary protection boundaries for sanitary protection zones have been proposed and new approaches have been developed to determine the protection zones of electric networks for ecological residential areas.

**Practical value of the research** The results of the study were tested in the organization of Ontustik Zharyk Transit LLP and the Department of Sanitary and Epidemiological Control of Abay district of Shymkent when developing basic digital maps of localities for the location of high-voltage power lines around residential ecological zones, and by processing basic data, it was proposed to expand the sanitary protection zone of high-voltage power lines.

- A geodata map was developed and plotted using the inverse distance weight method based on the Esri ArcGIS application program;

- gradients in the degree of danger of electric and magnetic fields were created, limiting sanitary protection zones from high-voltage power lines;

- a three-dimensional characteristic is constructed that visually shows the dependence of the time people stay in the electromagnetic radiation zone, which depends on the degree of radiation of the objects being emitted;

- an environmental assessment was carried out in residential ecological zones where there is a need to obtain specific data on the state of the environment in order to avoid risks;

- a new sanitary protection zone was set, which is the main regulatory document in the construction and when setting high-voltage lines around ecological zones;

- optimal routes of high-voltage power lines were developed, taking into account the terrain features of the selected territories;

**Approbation of results research:**

- selection of the main specific and point facilities in the city of Shymkent, which are located in the zone of active impact of electromagnetic fields on the environment;

- digitization of new digital maps, where the main gradients in the degree of danger of the electric and magnetic fields are indicated, taking into account the disturbing influences and factors in high-voltage power lines;

- the use of mathematical modeling methods and state-of-the-art information platforms of Esri ArcGIS for the processing of experimental data and the development of digital maps, where a refined security zone of electrical networks is visually presented in relation to residential ecological zones.

- assessment of changes in the security zone of electrical networks, taking into account its specific data that are directly related to the expansion of the sanitary protection zone in the residential environmental environment

**The main provisions presented for defense:**

- methodology for calculating the level of electromagnetic fields generated by low-frequency energy facilities by using ground-based laser scanning;
- threshold assessment of the level of electromagnetic pollution obtained by the theoretical calculation method based on the basic geometric parameters of high-voltage power transmission lines and distances to the object of interest (in our case, residential facility).
- the results of the environmental assessment study obtained by the method of basic calculations on the example of specific selected facilities;
- ecological forecast of changes in the level of electromagnetic fields depending on climatic changes in the environment, changes in the transmitted power of electric energy in different periods of time;
- optimal variants for the location of high-voltage power lines depending on residential ecological zones

**The author 's personal contribution** is presented by:

- identification of the main sources of electromagnetic radiation produced by high-voltage power lines on the example of residential ecological zones;
- calculations to determine the main levels of the electromagnetic field on high-voltage power transmission lines and the establishment of the main gradients in limiting the routes of power transmission lines according to the degree of its impact;
- solving the main issues of expanding sanitary protection zones, taking into account climatic and technological features that directly affect the fluctuations of electromagnetic fields produced by high-voltage lines;
- a proposal for the introduction of new sanitary protection zones for the class of high-voltage lines that are located in residential ecological zones.

**The contribution of the doctoral student in the preparation of the publication.** On the topic of the dissertation, Fayz N.S. published 10 scientific papers, including 1 article in the journal included in the Scopus/Web of Science database, 3 articles in journals recommended by the Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan, 4 theses in the materials of foreign conferences and 2 articles in other scientific publications. The total contribution of a doctoral student is 55-60%. The contribution to the articles is represented by such components as conducting experimental studies, processing in the form of tabular values and graphical dependencies, obtained computational equations

**Structure and scope of the dissertation.** The dissertation work is presented on 124 pages of the computer text, consists of 13 tables and 46 figures. The dissertation work consists of an introduction, 4 chapters, a conclusion, A list of sources and appendices used.