RATING OF NON-IONIZING RADIATION

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Summary: Standardization of non-ionizing radiation involves the creation of guidelines and regulations to ensure the safe use and exposure to non-ionizing radiation sources. Non-ionizing radiation includes various forms of electromagnetic radiation such as radio waves, microwaves, infrared radiation and visible light. The main purpose of standardization is to protect human health and minimize potential risks associated with exposure to non-ionizing radiation. This includes establishing exposure limits, developing measurement methods, and creating a regulatory framework to ensure compliance with safety regulations. International organizations such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the World Health Organization (WHO) play an important role in developing guidelines and recommendations on exposure to non-ionizing radiation. These recommendations take into account scientific research on the health effects of non-ionizing radiation and aim to balance technological advances with public safety.
Keywords: Non-ionizing radiation, Standardization, Health effects, Exposure limits, Measurement methods, Regulatory framework

To prevent the adverse effects of EMF on the population, maximum permissible levels of electromagnetic fields have been established.

In order to protect the population from the effects of EMF, sanitary protection zones are installed around radio stations and high-voltage lines (VL). The sanitary protection zone of high-voltage lines , in which the electric field strength exceeds 1 kV/ m , is the territory along the overhead line route, including : 20 m - for overhead lines with a voltage of 330 kV, 30 m - 500 kV, 40 m - 750 kV, 55 m - 1150 kV.

Normalization of ionized radiation exposure

Work with radiation sources and protection from ionizing radiation is regulated by the “Radiation Safety Standards” (NRB-96) and hygienic standards GN 2.6.1.054-96, which establish a system of dose limits, principles of their application, rules for working with radioactive substances and other sources of ionizing radiation. These documents take into account the world experience of the International Commission on Radiation Protection (ICRP). NRB-96 establishes the following categories of exposure of persons:

- *Category A* – personnel (professional workers) – persons who permanently or temporarily work directly with sources of ionizing radiation;
- *Category B* – a limited part of the population - persons who do not work directly with sources of radiation exposure, but due to their living conditions or workplace location may be exposed to radioactive substances.

NBR-96 are used to ensure human safety in all conditions of exposure to ionizing radiation of artificial and natural origin. For these categories of irradiated people, three classes of standards are provided:

- *basic dose limits* (maximum permissible dose - for category A ; dose limit - for category B);
- *permissible levels* (permissible dose rate, permissible flux density, permissible radionuclide content in a critical organ, etc.);
- *control levels* (doses and levels) established by the administration of the institution in agreement with the State Sanitary and Epidemiological Supervision at a level below the permissible level.

Basic dose limits have been established for three critical organs. Critical organ - an organ, tissue, part of the body or the entire body, the irradiation of which causes the greatest harm to the health of a person or his offspring. The division of critical organs into groups is based on the law of radiosensitivity Bergonier-Tribondo , according to which the most sensitive to ionizing radiation are the most differentiated tissues, characterized by intensive cell proliferation.

The first group of critical organs includes the gonads, red bone marrow and the entire body, if the body is irradiated with uniform radiation. The second group includes all internal organs, endocrine glands (with the exception of gonads), nervous and muscle tissue, and other organs that do not belong to the first and third groups. The third group includes skin, bones, forearms and hands, ankles and feet.

NRB-96 uses the following as the main dose limits:

- maximum permissible dose of radiation per year for personnel (category A) working with sources of radioactive radiation SDA, J/kg. It means that with systematic, uniform exposure over 50 years, there should be no adverse changes in human health that can be detected by modern research methods, now and in subsequent years (Table 3.17);
- radiation dose limit per year for the population (category B) PD, J/kg, or rem, which in practice is always set significantly less than the MDA value to prevent unnecessary exposure of people. The maximum permissible (effective) dose of radiation per year is determined by multiplying the equivalent dose in an organ by the corresponding weighted coefficient for a given organ or tissue. It is used as a measure of the risk of long-term consequences of human exposure (Table 3.17).

PD carries a very low risk of harmful effects. The likelihood of somatic (direct damage or the appearance of diseases) and genetic (manifestations of harmful effects on descendants in 2-3 generations) effects is at least an order of magnitude lower compared to the risk from a complex of factors of various nature ("background risk"). The permissible concentration for persons of category B (AC) is a derived value from the PD and is set based on achieving the dose limit by the end of life (70 years) with an average annual volume of inhaled air of $7.3 \times 10\,6$ liters.

Table 1 – Main dose limits according to NRB-96

Standardized quantities	Dose limits	
	Category A	Category B

Effective dose	20 m3v per year on average for any after-effects - valid 5 years, but not more than 50 mSv per year	1 mSv per year on average for any consecutive 5 years, but not more than 5 mSv per year
Equivalent dose per year: in the lens; in a layer of skin with a thickness of 5 microns / cm ^{2} ; in the hands and feet	150 mSv 500 mSv 500 mSv	15 mSv 50 mSv 50 mSv

Unlike a chemical substance, the DC is established in units of radioactivity, becquerels (Bq) per cubic meter. DCs calculated from the condition of PD formation due to irradiation with radionuclides entering the body only through inhalation are tabulated in NRB-76/87.

Due to the need to take into account all routes of entry of radionuclides into the body, as well as external exposure, internal exposure from substances received via inhalation will account for only part of the PD, therefore the calculated DC will almost always be less than those given in the NRB.

Acceptable level indicators :

- maximum permissible annual intake of radioactive substances into the body of workers (MAP, kBq /year), which for 50 years creates a dose equal to 1 MAP in a critical organ;
- the limit of the annual intake of radioactive substances into the human body (GWP, kBq /year) for 70 years , creating an equivalent dose equal to 1 PD in a critical organ;
- permissible average annual content of radioactive substances in the body (critical organ) DS, at which the radiation dose is equal to the PPD or PD, kBq ;
- permissible surface contamination (soil, clothing, transport, premises, etc.) DZ, particle / (cm ^{2} × min).

Benchmarks are established for planning activities and for operational monitoring of the radiation situation in order to prevent exceeding the dose limit of contamination. These indicators include:

- control annual intake of radioactive substances into the human body KGP, kBq /year ;
- control content of radioactive substances in the human body KS, kBq ;
- control concentration of a radioactive substance in the air or water with which it enters the human body CC, kBq /m ^{3} ;
- control contamination of the surface with radioactive substances short circuit, particle/(cm ^{2} × min).

2. Standardization of anthropogenic impact on the natural environment

The following standards for permissible environmental impact are established for legal entities and individuals who use natural resources :

- standards for permissible emissions and discharges of substances and microorganisms;
- standards for the generation of production and consumption waste, limits on their disposal;

- standards for permissible physical impacts (amount of heat, noise levels, vibration, ionizing radiation, electromagnetic field strength, etc.);
- standards for permissible removal of components of the natural environment;
- standards for permissible anthropogenic load on the environment.

They must ensure compliance with environmental quality standards , taking into account the natural features of territories and water areas.

Permissible exposure standards establish requirements for a source of harmful impact, limiting its activity to a certain threshold concentration from the point of view of environmental protection of the natural environment. This primarily applies to emissions and discharges of pollutants into the atmosphere and hydrosphere, respectively.

The close attention to emissions and discharges is explained by the following. Sanitary and hygienic standards (MAS) prevent direct effects on human health, but do not exclude the possibility of adverse effects on the environment. In this regard, standards are being developed for industrial enterprises to limit emissions (discharges) of absolute quantities of chemicals into the environment, i.e. standards for anthropogenic impacts. They apply only to two environments of the natural sphere: the atmosphere and the hydrosphere. This is due to the fact that these environments are the main objects of pollution, and all other components of the environmental environment (soil, plants, etc.), as a rule, are polluted indirectly.

Anthropogenic impact standards are calculated emission standards for permissible emissions (discharges) of various harmful substances per unit of time (usually per year), established for each enterprise separately, but taking into account the total amount of pollutants emitted into the atmosphere or discharged into the hydrosphere by other enterprises. They are called maximum permissible emissions (MPE) of harmful substances into the atmosphere, maximum permissible discharge (MPD) of pollutants into water bodies.

MDS is the mass of a substance in wastewater, the maximum permissible for disposal in the established mode at a given point per unit of time in order to ensure water quality standards at the control point.

MPE is the amount of harmful substance allowed to be released from a given source, which does not create a ground concentration dangerous for people, animals and plants.

With the help of these standards, the emission of emissions (discharges) of an enterprise in a specific territory is limited. They are controlled technical indicators of the environmental activities of the enterprise. Their use is aimed at creating waste-free (low-waste) production, although their modern use represents some intermediate version of this process.

The development of maximum permissible values (PDS) is carried out at two levels: either by regional environmental protection departments (committees), or by the enterprises themselves on the basis of the legislative and regulatory framework (with subsequent approval). In connection with the development of the district, region, and, consequently, changes in territorial and industrial conditions, they are revised every 3-5 years.

Calculation of MPC and MPC (in g /s) is carried out within the framework of a formally identical physical formula based on the condition of not exceeding MPC for a given productivity (volume of emissions/discharges) in a specific territory (for example, on the border of a sanitary protection zone):

$$\frac{ПДВ}{ПДС} = K_p \times ПДК \quad , (3.10)$$

where K_p is the dilution factor of the pollutant with clean air (the case of MPE) or clean water (the case of MPE); physically it represents the volume of clean air (or clean water) necessary to dilute the pollutant emitted per unit of time to the concentration allowed by sanitary standards (i.e. to the MPC level);

$ПДК$ – maximum permissible concentration of pollutant in emissions/discharges, g /m ^{3} (g/l).

However, the use of equation (3.10) to calculate the MPE/MPD has significant methodological features. The calculation is carried out taking into account:

- patterns of dispersion of pollutants in the atmosphere or water body;
- superposition of emitted/discharged pollutants on their background content in the atmosphere or water body;
- the cumulative impact of all other sources of pollution on the components of the natural environment in a given territory (number of sources of pollution, terrain, presence of green spaces, weather conditions, etc.)

Let us consider the features of standardization of emissions into the atmosphere and discharges into the hydrosphere.

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