Federal State Budgetary Educational
institution of higher education
"North Ossetian State Medical Academy"
of the Ministry of Health of the Russian Federation

DEPARTMENT OF GENERAL HYGIENE
AND PHYSICAL CULTURE

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PHYSICAL FACTORS OF THE WORKING ENVIRONMENT AND THEIR IN FLUENCE ON THE HUMAN BODY

Methodological guide for students of the medical faculty

Vladikavkaz 2016

UDC 613.6
LBC 51.24

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Physical factors of the working environment and their influence on the human body: methodological guide for students of the medical faculty

North Ossetian State Medical Academy. - Vladikavkaz, 2016 . – 19 p.

This methodological manual contains material reflecting modern hygienic ideas about the main harmful production factors of a physical nature and methods of their prevention. The data on the influence of working noise, vibration, infra- and ultrasound, electromagnetic radiation of ionizing and non-ionizing nature on the body are presented. Information on the classification, MPC and MPL of these factors, methods of their research and prevention is given.

The manual is supplied with tables, test tasks, situational tasks, a list of basic and recommended additional literature that facilitate the assimilation of the material.

Methodical recommendations "Physical factors of the working environment and their influence on the human body", prepared in the discipline "Hygiene" in accordance with the Federal State Educational Standard of Higher Professional Education for students studying in the specialty General Medicine (05.31.01).

UDC 613.6
LBC 51.24

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Approved and recommended for publication by the Central Coordination Educational and Methodological Council of the FSBEI of HPE NOSMA of the Ministry of Health of Russia (Minutes No. 1 dated September 12, 2016).

Industrial noise

Production noise is a physical factor. Due to the growth of its intensity in recent years, it has become more important hygienic, as it accompanies the work of representatives of numerous professions.

For most medical specialties noise is not an actual production factor, except for some specialists.

Noise is a set of sounds of different intensity and frequency, randomly changing in time, arising in production conditions and causing discomfort, objective changes in organs and systems. Sound is the periodic mechanical vibrations of a certain frequency propagating in an elastic medium. Depending on the environment in which the sound propagates, distinguish air and structural noise. The sound wave propagating in an elastic medium is an alternation of areas of thickening and rarefaction of the medium, i.e., an oscillatory process.

Perceived by the human ear, the sound range includes frequencies from 20 Hz to 11.2 kHz. When the frequency of the oscillations below 20 Hz are saying about the infrasound, and above 11.2 kHz - ultrasound.

Characteristics of sound waves:

- frequency (spectrum);
- wavelength;
- intensity (power).

One of the important characteristics of sound vibrations is the frequency of propagating oscillations. The frequency of vibration - number of complete vibrations executed within 1 sec. The unit of frequency-Hertz (Hz) is 1 oscillation per second. The oscillation frequency can be from units to many thousands of Hertz. The frequency composition of the noise characterizes its spectrum, i.e. the set of frequencies included in it. The entire audible frequency range is divided into 3 octaves with mid-geometric frequencies: 16, 31, 63, 125, 250, 500, 1000, 2000, 4000, 8000 and 16,000 Hz.

Noise classification

Time characteristic	*Character spectrum*	*Origin*	*Frequency*
1.permanent 2.non-permanent: -oscillating - oscillating - intermittent - impulsive	1.broadband 2.tonal	1. aerodynamic 2. mechanical 3.hydrodynamic	1. low-frequency: below 300 Hz 2. mid-frequency: below 800 Hz 3. high frequency: over 800 Hz

Subjectively perceived value of sound is called its volume, frequency determines the pitch, and a set of frequencies (acoustic spectrum) - the timbre of sound.

Sound vibrations, like any wave motion, obey the laws of interference and diffraction. The process of overlapping several sound waves is called interference. The diffraction of waves with obstacles is called diffraction. When a sound wave collides with an obstacle, it is possible to transfer part of the sound energy through the obstacle (refraction), return part of the energy back (reflection) and absorb sound energy. All these features of sound waves are used in the design of noise protection devices.

The effect of noise on the body

Sound waves, meeting on the way of any surface (solid, liquid), transmit these vibrations to them. A similar obstacle to the sound wave can serve as a hearing organ, which consists in a person of the auricle with the auditory passage (outer ear), the tympanic membrane connected to the system of auditory bones (middle ear), and the inner ear. The sound wave causes vibrations of the tympanic membrane, which, driving the system of the bones of the middle ear, are transmitted to the ends (receptors) of the auditory nerve, causing them to the corresponding nerve impulses sent to the brain. A more intense sound, that is, with more energy fluctuations is perceived as a loud, less intense-as a quiet. To measure the noise intensity, a logarithmic scale in decibels relative to the hearing threshold of a person with normal hearing is used. This value, equal to 2x10 ' 5 Newton per 1 m2, is taken as 1 decibel (dB).

When the intensity of the sound is increased, the pressure exerted on the eardrum

can cause pain. The intensity of sound is called the threshold of pain and is in the range of 130 dB.

The audio portion of the vibrational spectrum has a huge range of frequencies - from 20 Hz to 20,000 Hz. Sounds of different frequencies even at the same intensity are perceived differently. Low-frequency sounds are perceived as relatively quiet; as the frequency increases, the volume of perception increases, but approaching the high-frequency oscillations, and especially to the upper limit of the sound spectrum, the volume of perception falls again. Most well the human ear perceives vibrations in the range of 500 - 4000 Hz. Given these features of perception, to characterize the sound or noise in General, it is necessary to know not only its intensity, but also the spectrum, that is, the frequency of sound wave oscillations.

In production conditions, as a rule, there are noises of different intensity and spectrum, which are created as a result of various mechanisms, units and other devices. They are formed as a result of rapid rotational movements, sliding (friction), single or repeated shocks, vibration of instruments and individual parts of machines, etc.Noise has in its composition different frequencies, and yet each noise can be characterized by the predominance of certain frequencies. Conventionally, the whole spectrum of noise is divided into low – frequency - with a frequency of up to 350 Hz, medium - frequency-from 350 to 800 Hz and high-frequency-over 800 Hz.

To low-frequency noise include low-speed units of unsatisfactory action, noise penetrating through sound-insulating barriers (walls, floors, casings), etc.; to the medium-frequency noise include most machines, units, machines and other moving devices of unsound action; to high-frequency include hissing, whistling, ringing noise, typical for machines and units operating at high speeds, shock action, creating strong air or gas flows, etc.

Production noise of different intensity and spectrum (frequency), long-term impact on workers, can lead over time to a decrease in hearing acuity, and sometimes to the development of professional deafness. This adverse effect of noise is associated with prolonged and excessive irritation of the nerve endings of the auditory nerve in the inner ear (cortical organ), resulting in fatigue, and then partial destruction. Studies have

found that the higher the frequency composition of noise, the more intense and longer, the faster and stronger the adverse effect on the hearing. With excessively intense high-frequency noise, if the necessary protective measures are not carried out, it is possible to defeat not only the nerve endings, but also the bone structure of the cochlea, and sometimes the middle ear.

Along with the specific manifestations of noise pathology there are non-specific changes in the form of:

- neurasthenias';
- vegetative-vascular dysfunction syndrome;
- headache;
- unsystematic dizziness;
- loss of memory;
- increased fatigue;
- emotional instability;
- sleep disturbance;
- heartache.;
- decreased appetite;
- dysfunction of the stomach (the violation of the evacuation function, the change in the acidity);
- reduction of immunological reactivity, General resistance of the organism.

Noise is an external stimulus, which is perceived and analyzed by the cerebral cortex, resulting in intense and long-acting noise occurs overvoltage of the Central nervous system, extending not only to specific auditory centers, but also to other parts of the brain. As a result, the coordinating activity of the Central nervous system is disrupted, which leads to a disorder of the functions of internal organs and systems. Workers who have been exposed to intense noise for a long time, especially high-frequency noise, have complaints of headaches, dizziness, tinnitus, and medical examinations reveal peptic ulcer, hypertension, gastritis and other chronic diseases.

Intensive noise exposure causes changes in the auditory analyzer that make up a specific reaction of the body. The process of adaptation is expressed in the increase of

auditory thresholds (auditory fatigue, gradual displacement of the hearing threshold).

Intensive noise in production conditions is often caused by a persistent decrease in sensitivity to different tones and whispering (professional hearing loss and deafness). The development of professional deafness is associated with the sound-receiving apparatus of the cortical area of the auditory analyzer. Under prolonged work in conditions intense noise, especially high-frequency, comes gradual weakening of audibility first high, and then and other tones, which can lead to full deafness.

Methods and means of noise protection

Various methods are used to reduce noise in industrial premises:

- reduce the sound power of the noise source;

- rational placement of the noise source relative to workplaces and populated areas, taking into account the direction of sound energy radiation;

- acoustical treatment of buildings (insulating materials);

- sound insulation (installation of casings, screens, booths, partitions between the noise source and the workplace);

- the use of noise mufflers;

- the use of personal protective equipment (ear buds, headphones, helmets).

Ear pads can reduce the sound pressure level by 10-15 dB, headphones-up to 38 dB.

Maximum permissible noise levels

- 40 dB-noise of hospital rooms, libraries, household noise;

- 45 dB-for rooms intended for mental work;

- 55 dB-for design offices;

- 60 dB - indoor remotes and cabin surveillance;

- 70 dB-for laboratory rooms;

- 80-90 dB - for jobs in the shops.

Vibration

Vibration is small mechanical vibrations that occur in elastic bodies. In biology and medicine, vibration is usually associated with mechanical oscillatory movement of the body, individual organs or tissues, which occurs under the influence of external

factors. Harmonic oscillation-the simplest form of vibration-the considered point of the structure is shifted in a given direction from the equilibrium position depending on the time according to the sine-distance law. The period of oscillation is the time during which the material body makes one complete oscillation. Oscillation frequency is the number of full oscillations per time unit. One oscillation per second (Hz) is taken as the unit of frequency. Storms and earthquakes are a natural source of vibration. Artificial - different engines, vehicles, loudspeakers, Vibroscreen, etc. handed down through the rebar, soil, floors, water, the atmosphere, the vibrations can travel considerable distances and reach individual sections of the human body or affect the whole person, causing local or General effects (local or General vibration). The frequency spectrum of vibration covers infrasonic frequencies - up to 16 Hz, sound-from 16 to 20000 Hz and ultrasonic over 20000 Hz. The frequency of vibrations that can cause a person the most specific vibration sensation, usually lies in the region up to 8000 Hz.

The biological effect of vibration is determined by the local in-tensionally of vibrational energy, causing in the tissues of alternating stresses: compression and stretch, a shift from the natural axis of peace, torsion and bending of the tissues and fluids. Vibration facilitates the circulation of liquid, can cause the decay of molecules in the cell protoplasm, intensifies enzymatic reactions, increases the permeability of cell membranes, can cause rearrangements in the chromosome apparatus of cells.

Vibration is classified:

- according to the method of transmission of vibrations to the person (the total vibration is transmitted through the support surface on the body of a sitting or standing person; local through the hands);

- in the direction of action (vertical, horizontal from the right shoulder to the left, from back to chest);

- on the time characteristic-constant (changing no more than 2 times); non-constant (more than 2 times for 1 min).

The effect of vibration depends on the frequency and amplitude of the oscillations, the duration of exposure, the place of application, etc.

When acting on the body of the General vibration primarily affects the muscu-

loskeletal and nervous system, as well as analyzers - vestibular, visual, tactile. The workers vibration of professions marked by dizziness, disorder of coordination of movements, symptoms of motion sickness.

In addition, vibration can cause the body to rearrange many functions by involving the CNS, autonomic nervous and endocrine systems in the reaction. Moderate doses of ieintieivnoy vibration have a stimulating effect on the Central nervous system, increase the lability of the neuromuscular apparatus, intensify the redox processes and activities of the pituitary system, the adrenal cortex, thyroid gland, etc., which is used for therapeutic purposes. Increasing the dose of vibration leads to functional and morphological disorders in the body.

With local vibration, the regulation of the tone of peripheral blood vessels suffers. Vibration stimulation of smooth muscle cells of blood vessels leads to angiospasm and changes in hemodynamics in the microcirculation. Irritation of the circulatory nerve plexus leads to a violation of trophism and vasomotor coordination, also violated the plasticity of the lymphatic channel. With local vibration there are pathological changes in the neuromuscular apparatus: reduced electrical excitability and lability of muscles and peripheral nerves, weakened reflexes, impaired motor coordination. In humans, long-running, with Vibroscreen, reduced strength, tone and endurance of the muscles, in the muscles, there are pockets of seals, painful strands, develop atrophy.

Overall vibration is causing similar disorders in the whole of the motor area. But the overall vibration is particularly vulnerable to the CNS.

At the same time, inhibitory processes begin to prevail in the cerebral cortex, vegetative dysfunction occurs. Clinically, this is expressed in fatigue, depression or irritability, headaches and other disorders, develop severe neuroses.

Vibration causes disturbances of hydrodynamic balance in tissues and increase of total energy consumption of the body with shifts in redox processes. There may be internal injuries due to displacement. Thus, with prolonged exposure to vibration, a person develops a vibration disease.

Chronic exposure to vibration causes progressive changes in histological,

histochemical, biochemical organs and tissues: swelling and hemorrhage in the brain and spinal cord, dystrophic changes in neurons, nerve trunks, dystrophic changes in muscle tissue and muscle tears, the growth of connective tissue, swelling, bleeding and dystrophic changes in parenchymal organs, violations of morphological and biochemical composition of blood. In the arteries are changes such as those in obliterating endarteritis. Possible trophic changes in the skin and its appendages, the development of gangrene fingers. In the osteo-articular apparatus of developing osteoporosis, deforming arthrosis, osteochondropathy, possible avascular necrosis of the heads of the bones, sealing with the deposition of lime osteophytes.

The clinical picture of vibration disease develops gradually. The symptoms of the initial period are polymorphic, nonspecific. Most often, patients complain of pain in the hands or feet, paresthesia, cramps in the fingers, chilness. From the early common manifestations of the disease, symptoms of General neurotization are characteristic: irritability, insomnia, mood variability. Observed polyneuritises and angiodistonia symptoms. Ranks retinopathy syndrome: the whitening of the fingers after cooling, disorders of pain, temperature, vibration sensitivity. There are hyposthesia by type of socks and gloves, in the subsequent - disorders of sensitivity of segmental type. The phenomena of hyperkeratosis, pachydermia, effacement of dermal pattern of finger tips, swelling.

Vibration disease caused by the impact of General vibration, characterized by significant changes in the Central nervous system and occurs with polyneurotic syndrome, migraine-like syndrome. In severe cases, possible diencephalic syndrome and symptoms of multiple micro focal symptoms. Other common symptoms should be noted ECG changes initially noncardiac in nature: the instability of the heart (elektrosistemy), change the final part of the ventricular complex is electrolytic nature. Subsequently, signs of chronic heart muscle damage of a dystrophic nature, disorders of the digestive system – gastritis, dyskinesia; disorders of carbohydrate, mineral, vitamin metabolism develop.

There are 4 stages of development of vibration disease:

Stage I-transient pain in the fingers, paresthesia, numbness.

Stage II-pain and paresthesia are more pronounced, are stable, revealed changes in vascular tone, distinct sensory disorders. Develop autonomic dysfunction and the phenomenon of fatigue.

Stage III-vasomotor and trophic disorders become pronounced, there are attacks of pain, numbness and paresthesia, a distinct syndrome of vasospasm (finger whitening, mixed sensitive disorders— peripheral, often segmental). Characterized by complete loss of vibration sensitivity, depression or loss of tendon reflexes, neurotization of the individual, vegetative-vascular dystonia of hypertensive type with hyperhidrosis. There are gastrointestinal disorders. Radiological changes are detected in the joints and bones.

Stage IV-develop generalized organic lesions, such as encephalomyelopathy. Trophic and sensitive disorders are pronounced. Pain syndrome in the fingers, along the nerve trunks, in the joints is persistent. Angiodistonia crises include not only the peripheral vessels of the arms, but also the coronary and cerebral vessels.

In some cases, there is a combination of individual syndromes or their interlacing:

1. Amiodaronesee syndrome: is observed in all stages, is characterized by cold, cyanosis of extremities, paresthesia.

2. Angiospasticescoy syndrome: attacks of vasospasm is the type of "white finger" and expressed by the human sensitivity.

3. Vegetative polyneuritis syndrome: paresthesia, pain, sensitivity disorders.

4. Syndrome vegetatively: pronounced dystrophic changes in muscles, other tissues of the musculoskeletal apparatus.

5. Syndrome nephritis: marked amyotrophy of the election in the appropriate area of nerve injury.

6. Diencephalic syndrome. Characterized by bouts of vertigo, often on the background of fatigue.

Methods and means of vibration protection

Prevention of harmful effects of vibration on the body includes measures of organizational, technical, hygienic, therapeutic and preventive nature.

Organizational and technical measures-the creation of machines and mechanisms with safe vibration characteristics, vibration automation. To protect against vibration, the following methods are used:

- Reduction of vibration activity of machines
- Vibrodisplacement - is applied on a vibrating surface soft surfaces (rubber)
- Vibration damping - carry out the installation of units on a massive fundament.
- Vibration isolation-isolation of vibrating surfaces from each other by means of springs, gaskets.

Hygienic and preventive measures include the implementation of a rational physiological operation vibrantly-ment and labor organization, conducting preliminary and periodic examinations of workers. They recommend individual complexes of special gymnastics, self-massage at the end of the working day (shift), water procedures. Vitamin fortification of food, means of individual protection from vibration, antivibration gloves, gloves, pads and towels.

The factors of the working environment, aggravating the harmful effects of vibrations on the body, include excessive muscle load, low temperature, high humidity, noise, psycho-emotional stress.

INFRASOUND

Infrasound is a mechanical vibration propagating in an elastic medium (e.g., solid, liquid or gaseous) with a frequency of less than 20 Hz. It is characterized by the same parameters as the sound. The greater the amplitude of the oscillations, the greater the infrasonic pressure and infrasound force.

The sources of infrasound in industrial enterprises are fans, compressor units, all slowly rotating machines and mechanisms. The most powerful sources of infrasound are jet engines. In normal urban and industrial environments, infrasound levels are low, but even weak infrasound from urban transport is included in the General background noise of the city and is one of the causes of nervous fatigue of residents.

Under the influence of infrasound increases metabolism, there are weight-tibular disorders, decreased visual acuity, and hearing changes in the rhythm of breathing and heart rate. At the same time, there may be violations of peripheral blood circulation,

CNS activity, digestion.

Infrasound vibrations cause a person to feel deep pressure and inexplicable fear.

Infrasound is harmful in all cases: weak acts on the inner ear and causes symptoms of seasickness, strong causes damage to the internal organs due to their strong vibration. Infrasound average power can cause blindness.

Protection from infrasound

It is almost impossible to stop infrasound with the help of barriers to its spread. The only means of protection is to reduce the level of infrasound in the source of its formation.

Preventive control:

- increase shaft speed to 20 or more revolutions per second;

- elimination of low-frequency vibrations;

- making structural changes in the structure of the sources, which allows you to move from the field of infrasonic vibrations in the field of sound for Chet sound insulation and sound absorption.

ULTRASOUND

Ultrasounds (inaudible sounds) are mechanical vibrations of an elastic medium and differ from sound waves by a higher frequency exceeding the upper threshold of audibility.over 20 000 Hz.

Powerful ultrasonic vibrations of low frequency and high intensity are used in production for technological purposes: cleaning of parts, welding, soldering of metals. Weaker ultrasonic vibrations are used in diagnostics for research purposes.

Ultrasonic waves propagate in any elastic medium (liquid, solid, gaseous), better in metals, water, worse in the air. The greatest reflection of ultrasonic vibrations is observed at the water-air boundary; ultrasound passes well from water to biological tissues. When passing in different media, ultrasonic waves are absorbed by them to varying degrees, which is due to the selective effect. For example, the absorption properties of muscle tissue above fat; in the gray matter of the brain absorption is almost 2 times higher than in white; the greatest absorption is observed in the bone tissue, the smallest - in the cerebrospinal fluid.

The work of ultrasonic equipment is accompanied by the spread of ultrasonic vibrations in the environment. The impact of sound and ultrasonic vibrations on the body of workers occurs through the air and due to the direct contact of the hands working with the media in which the oscillations are excited (contact path of exposure).

Ultrasonic vibrations, penetrating deeply into the body, can cause serious local disorders in the tissues: inflammatory reaction, hemorrhage, and at high intensity - necrosis. Persons serving ultrasound equipment, present a variety of complaints of headache, dizziness, fatigue, sleep disorder, drowsiness during the day, irritability, increased sensitivity to sound. By the end of the shift, there may be an increase in body temperature, a decrease in the pulse, a slowdown in reflex reactions to external stimuli. In clinical examination, asthenic syndrome is observed.

Methods and means of protection against ultrasound.

Prevention of the adverse effects of ultrasound and accompanying noise on the body of workers must first be reduced to a minimum of the intensity of ultrasonic radiation and the time of action.

The installation of the ultrasound and their individual nodes should zvukoizolyatora by enclosing them in shelters, isolated in separate compartments or areas, cover sound-proof material, etc. If the impossibility of complete sound insulation is partial insulation and sound-absorbing screens and coatings. Contact irradiation with ultrasound is particularly dangerous, so the technological process of ultrasonic treatment should completely exclude the possibility of such exposure or reduce it to a minimum.

Baths for ultrasonic treatment from all external surfaces should be covered with a sound-proof layer and during operation to close their covers also with sound insulation. When opening the baths for loading, unloading of the processed details it is necessary to switch off the ultrasonic installation. If it is impossible to completely turn off the ultrasonic units, load the parts into the bath in a special metal grid or basket.

Installation and removal of parts in the machines for contact ultrasonic treatment are also performed when off. If you can not turn off the installation, these operations

are performed with special tongs. Metal and plastic shields are used as reflective screens to prevent the spread of ultrasonic vibrations.

The most common means of personal protection when working with ultrasound are anti-noise and gloves.

In identifying the initial signs of adverse effects of ultrasound on the body of workers need to temporarily stop working in contact with ultrasound (regular leave, transfer to another job.

All new entrants to work with ultrasound are subject to mandatory preliminary medical examination, and further periodic medical examinations at least once a year.

Human exposure to electromagnetic fields and radiation.

Electromagnetic fields (EMF) in the environment create power lines, electrical equipment, electrical appliances - all technical systems that generate, transmit and use electromagnetic energy.

The effect of EMF on the human body is determined by the frequency of radiation, its intensity, duration, individual characteristics of the body.

Long-term human exposure to EMF industrial frequency (50 Hz) causes headaches, lethargy, memory loss, sleep disorder, increased irritability, heart pain, etc.

It is necessary to limit the time of stay in the area.

Electromagnetic radiation.

The impact of EMR optical range: infrared, visible (light), ultraviolet radiation on humans do not have a fundamental difference. The most affected organs are the skin and eyes. In case of acute skin damage, burns and eye damage are possible.

Under the influence of infrared radiation (chronic irradiation) there is a sharp expansion of capillaries, increased skin pigmentation - red complexion in workers.

Visible (light) radiation of a nuclear explosion, for example, leads to burns of open areas of the skin, temporary blinding.

UV radiation is a vital factor that has a beneficial stimulating effect on the body. The optimal doses of UV stimulate heart activity and metabolism. The most vulnerable to UVI-eye. Effects on the skin-inflammation with redness, blisters, fever, chills, headache. UVI is about 5% of the solar radiation flux density. However, atmospheric

pollution reduces its transparency to UVI.

UV from artificial sources (e.g. welding arcs) can cause acute and chronic lesions of the Professor.

Laser radiation (LI) - a special kind of EMR. The difference from other types of AMY is monochromaticity (waves is strictly the same length) and acute directional beam.

There are direct laser radiation, scattered, mirrored.

The degree of exposure to the body DEPENDS on the intensity of radiation, exposure time. The irradiation of the eye is easily damaged cornea and lens (heating of the lens to cataract formation). Skin damage can vary from redness to charring.

According to the degree of danger of radiation lasers are divided into completely safe and dangerous. Lasers are used in communication systems, in metal processing technology, in medicine, in control and measuring equipment, in military equipment and other fields.

Protection against electromagnetic fields and radiation.

Protection of the person from dangerous influence of electromagnetic radiation is carried out by a number of ways, the main of which are:

- reduction of radiation directly from the source;
- shielding of the radiation source or workplace (metal mesh);
- application of PPE: protective robes, overalls, glasses.

Their protective properties are determined by the degree of reflection of the waves. Material for protective gowns and overalls - special fabric, in the structure of which thin metal threads are twisted with cotton threads.

Ionizing radiation.

Radiation danger to the population and the environment is associated with the appearance of ionizing radiation (AI), the source of which are artificial radioactive chemical elements (radionuclides), which are formed in nuclear reactors or nuclear explosions. Radionuclides can get into the environment as a result of accidents, increasing the radiation background of the earth.

Sources of radiation: natural (cosmic rays, terrestrial radiation, gas - radon), ar-

tificial (x-ray, radiotherapy installations for cancer treatment; nuclear explosions; nuclear power plants.

Ionizing radiation is called radiation that can ionize the environment (to create separate electrical charges).

To AI include x-ray, gamma radiation, alpha and beta radiation.

Passing through the medium (biological tissue) AI ionize it, which leads to physical, chemical or biological changes in the properties of the medium (tissue).

AI passing through various substances, interacts with their atoms and molecules. This interaction leads to the excitation of atoms and the separation of individual electrons from the atomic shells. As a result, an atom devoid of one or more electrons turns into a positively charged ion. A detached electron with a certain energy can further ionize other atoms.

When ionization of the body, metabolic processes, normal functioning of the nervous, endocrine, immune, respiratory, cardiovascular and other systems are disturbed, as a result of which people (animals) get sick.

AI cause radiation damage, which is usually divided into somatic (physical) and genetic. Somatic effects are manifested in the form of acute and chronic radiation sickness, local radiation injuries (eg, burns), as well as in the form of long-term reactions of the body, such as leukemia, malignant tumors, early aging. Genetic effects may occur in later generations.

The consequences of irradiation for persons determined by the magnitude of radiation dose and storage time.

The energy transmitted to the substance by ionizing radiation is called the absorbed dose and is expressed in 1 Gy (Gy) = 100 rad of non-systemic units. (Absorbed dose-the energy of AI absorbed by the irradiated body, in terms of unit weight).

The absorbed dose depends on the type of AI, because the biological effects on the body of gamma rays, neutrons, alpha and beta radiation are different in their activity. Therefore, it is better to use the equivalent dose unit-sievert (SV) or REM.

1 SV = 100 REM

The equivalent dose is the absorbed dose multiplied by the coefficient reflecting

the ability of this radiation to damage the tissues of the body.

At a dose of 100 rad (1 Gy) and above develops acute radiation sickness of varying severity. Radiation doses of 600-700 rad are considered to be almost fatal.

Acute lesions develop with a single uniform gamma irradiation of the whole body and an absorbed dose of more than 0.25 gray.

At a dose of 0.25 - 0.5 Gy, temporary changes in the blood can be observed, which quickly normalize.

At a dose of 0.5-1.5 Gy there is a feeling of fatigue, less than 10% of the irradiated may experience vomiting.

At a dose of 1.5-2.0 Gy-a mild form of acute radiation sickness, which is manifested by a prolonged decrease in lymphocytes in the blood, vomiting is possible in the first day after irradiation. Deaths are not recorded.

Radiation sickness of moderate severity occurs at a dose of 2.5-4.0 Gy. Almost all in the first day-nausea, vomiting, sharply reduced white blood cells in the blood, in 20% of cases can be fatal, death occurs 2-6 weeks after irradiation.

At a dose of 4.0-6.0 Gy, a severe form of radiation sickness develops, resulting in 50 % of deaths within the first month.

At doses above 6,0-9,0 Gy in almost 100 % of cases, an extremely severe form of radiation sickness ends in death due to hemorrhage.

Chronic radiation sickness can develop with continuous or repeated exposure at doses significantly lower than those that cause the acute form. Signs of chronic form-changes in the blood, disorders of the nervous system, local skin lesions, damage to the lens, reducing the body's immunity.

The degree of exposure to radiation depends on whether the radiation is external or internal (when radioactive substances enter the body with inhaled air, water, food, and through the skin).

Elements of technical devices, especially radio-electronic equipment, lose or change their properties during ionization parameters, and can fail under strong irradiation.

Protection against ionizing radiation:

Protection against ionizing radiation can be achieved by using the following principles:

- - "quantity" protection: using sources with minimal radiation by switching to less active sources, reducing the number of isotopes;

- protection "time": reducing the time of work with the source of ionizing radiation;

- protection "distance": the distance of the workplace from the source of ionizing radiation;

- protection screens: shielding the source of ionizing radiation. Screens can be mobile or stationary, designed to absorb or attenuate ionizing radiation. The walls of containers for transportation of radioactive isotopes, walls of safes for their storage can serve as screens.