# ҚОРАҚАЛПОҒИСТОНДА ФАН ВА ТАЪЛИМ

# ҚАРАҚАЛПАҚСТАНДА ИЛИМ ҲӘМ ТӘЛИМ

# НАУКА И ОБРАЗОВАНИЕ В КАРАКАЛПАКСТАНЕ

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# THE EFFECT OF ULTRASOUND ON THE HEALTH OF WORKERS

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***Summary:*** *The most common sources of ultrasound are piezoelectric and magnetic transducers. In addition, in industrial conditions, low-frequency ultrasound is often generated during aerodynamic processes: the operation of jet engines, gas turbines, powerful air engines, etc. Ultrasound is a mechanical vibration of an elastic medium, propagating in the form of alternating compression and rarefaction; Frequencies above 16-20 kHz are not perceived by the human ear. As the frequency of ultrasonic vibrations increases, their absorption by the environment increases and the depth of penetration into human tissue decreases. Absorption of ultrasound is accompanied by heating of the environment. The passage of ultrasound in a liquid is accompanied by the effect of cavitation.*

***Key words:*** *ultrasound, piezoelectric and magnetic transducers, airway exposure*

**Introduction.** Recently, technological processes based on the use of ultrasound energy have become increasingly widespread in production. In industry, ultrasound is used to assess the quality of welds in aircraft and rocketry.

Ultrasound has also found its use in medicine in the diagnosis and treatment of various diseases. Due to the increase in the unit power and speed of various units and machines, the noise level is increasing, including in the ultrasonic frequency range..

Ultrasound-20kHz is a mechanical vibration of an elastic medium with a frequency exceeding the upper limit of hearing. There are two types of ultrasonic vibrations - contact and air.

Contact ultrasound has a local effect on the body, as it is transmitted through direct contact with the ultrasound device, workpieces, or the environment in which ultrasound vibrations are generated.

Under the influence of local (contact) ultrasound examination, autonomic polyneuritis of the hands (less often in the legs) of varying severity appears, up to the development of paresis of the hands and wrists and autonomic vascular dysfunction.

Airway exposure to ultrasonic vibrations generated by low-frequency ultrasound of industrial equipment has a negative effect on the human body. Long-term systemic effects of air ultrasound cause diseases of the nervous and cardiovascular systems, reduce metabolic processes in the body, and cause hearing loss.

The severity of the changes depends on the intensity and duration of the ultrasound exposure to the person through the air, and increases in the presence of high-frequency noise in the spectrum, while adding a clear hearing loss.

If contact with ultrasound continues, these disorders will become more stable.

The nature of the changes that occur in the body under the influence of ultrasound depends on the exposure dose.

Small doses have a stimulating effect - micro-massage accelerates metabolic processes, which is successfully used in medicine to treat various diseases.

Larger doses and longer exposure time of ultrasound to the body lead to disruption of various body systems.

## Results

Measures to prevent the negative effects of ultrasound on the body of operators of technological devices and employees of treatment and diagnostic rooms consist, first of all, of carrying out activities of a technical nature:

- creation of automated ultrasound equipment with remote control;

- use of low-power equipment as much as possible, which helps to reduce noise and ultrasound intensity in the workplace by 20-40 dB;
- placing the equipment in soundproof rooms or remote controlled rooms;
- steel or duralumin sound-proofing devices, enclosures, equipment for screens covered with rubber, anti-noise mastics and other materials;
- Automatic shutdown of ultrasound transducers that can be contacted by ultrasound (loading and unloading materials;
- The use of ultrasound devices with the longest frequency from the audible range - not less than 22kHz;
- it is recommended to use a special working tool with a vibration-isolating handle to protect the hands from contact effects of ultrasound;

If it is not possible to reduce the noise and ultrasound intensity to acceptable values due to production reasons, personal protective equipment should be used - noise protection, rubber gloves with cotton lining, etc.

**Table 1**

| Infrasound source | Characteristic frequency infrasound range | Infrasound levels |
|---|---|---|
| Car transport | The entire spectrum of the infrasonic range | 70-90 dB outside, up to 120 dB inside |
| Railway transport and trams | 10-16 Hz | 85 to 120 dB indoors and outdoors |
| Industrial devices of aerodynamic and shock effects | 8-12 Hz | 90-105 dB up to |
| Ventilation of industrial facilities and buildings, the same in the subway | 3-20 Hz | 75-95 dB up to |
| Reactive plane | Approx 20 Hz | Up to 130 dB outside |

**Prevention of harmful effects of ultrasound**

Technological measures are at the heart of preventing the harmful effects of ultrasound: creation of automatic ultrasound equipment (for washing dishes, cleaning parts), remote-controlled devices; transition to the use of low-power equipment. In this case, the intensity of ultrasound and noise is reduced by 20-40 dB (for example, ultrasonic cleaning of parts, soldering, drilling, etc.).

When designing ultrasonic devices, it is recommended to choose operating frequencies that are as much as possible in the audible frequency range (not less than 22 kHz) in order to avoid the effect of obvious HF noise. Ultrasonic devices that exceed the standards of noise and ultrasound must be equipped with soundproof devices: cases, screens made of steel or duralumin. Covered with sound-absorbing materials: ruberoid, technical rubber, plastic, anti-vibration, anti-noise mastic. Soundproof shelters of ultrasonic devices should be separated from the floor with rubber gaskets and should not have holes or holes. The Department of Labor Protection continues a series of articles on the negative effects of harmful factors on the human body and the fight against it. Today we will talk about ultrasound. Ultrasounds are mechanical vibrations of an elastic medium, which have the same physical properties as sounds, but exceed the upper limit of audible frequency (more than 20 kHz). Low-frequency ultrasounds (frequency - tens of kilohertz) have the ability to spread in the air, high-frequency

(frequency - hundreds of kilohertz) - fade away quickly. In elastic media - water, metal, etc. - ultrasound propagates well, and the temperature of these media has a significant effect on the propagation speed.

According to the method of propagation of vibrations, ultrasound is divided into contact (when hands or other parts of the human body come into contact with the source of ultrasound) and air (acoustic).

**Sources of ultrasound in the workplace**.

Artificial sources of ultrasound include all types of ultrasonic technological equipment, ultrasonic devices and equipment for industrial, medical and household purposes that generate ultrasonic vibrations in the frequency range from 20 kHz to 100 MHz and higher. The source of ultrasound can also be equipment that causes ultrasonic vibrations during operation as an accompanying factor. The main elements of ultrasonic technology are ultrasonic transducers and generators. At present, ultrasound is widely used in mechanical engineering, metallurgy, chemistry, radio electronics, construction, geology, light and food industry, fishery, medicine, etc. In production conditions, short-term and periodic contact effects of ultrasound occur when holding the tool, workpiece, loading products into baths, unloading them and performing other operations. The analysis of the prevalence and prospects of the use of various ultrasound sources showed that 60-70 percent of those working in conditions of negative effects of ultrasound are defect detectors, operators of cleaning, welding, cutting machines, ultrasound doctors (ultrasound), physiotherapists, surgeons, etc.

**Effects of ultrasound on the human body.** The changes that occur under the influence of ultrasound (air and contact) occur according to the general scheme: low intensity stimulates and activates, and medium and large ones weaken, inhibit and completely suppress functions. possible. The most studied biological effect of ultrasound is its contact behavior. Experience has shown that ultrasonic vibrations can penetrate deep into the body and cause serious local tissue damage: inflammatory reaction, bleeding, and at high intensity - necrosis.

Due to the short wavelength, high-frequency contact ultrasound is almost invisible in the air and affects workers only when the ultrasound source is in contact with the surface of the body. Changes caused by contact ultrasound are usually more pronounced in the contact zone, most often these are fingers, hands. Long-term work with ultrasound during contact with the hands causes damage to the peripheral neurovascular apparatus, and the severity of the changes depends on the ultrasound intensity, sound time and contact area, i.e. can increase in the presence of ultrasound effects and additional factors of the production environment that increase its effect (air ultrasound, local and general cooling, contact lubricants - various types of oils, static muscle tension, etc.).

Among those working with contact ultrasound sources, there was a high percentage of complaints about the presence of paresthesia, sensitivity of the hands to cold, a feeling of weakness and pain in the hands at night, decreased tactile sensitivity, sweating. There are also complaints of headache, dizziness, noise in the ears and head, general weakness, palpitations, pain in the heart region.

In people who are engaged in experimental work on ultrasound devices for a long time, sometimes diencephalic diseases (weight loss, sudden increase in blood sugar, slow decrease to the initial level, hyperthyroidism, mechanical muscle excitability, itching, paroxysmal attacks) occur. such as visceral crises).

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to the initial level, hyperthyroidism, mechanical muscle excitability, itching, paroxysmal attacks) occur. such as visceral crises).

Measures to protect and prevent the impact of ultrasound on workers should be aimed at limiting the impact of sound and ultrasound vibrations transmitted through air and communication. The main measure to reduce noise and ultrasound is to reduce their intensity at the source, but this way is not always technically possible. Industrial enterprises often use excessive intensity of ultrasonic vibrations, so first of all, attention should be paid to the rational selection of the power of the equipment. In cases where intensity reduction is not in the interest of technology, the most effective measure to reduce noise and ultrasound is to soundproof the equipment. Prevention of ultrasonic impact of the contact is achieved by shutting off vibrations during loading and unloading of parts, for which it is recommended to use automatic blocking.

To a large extent, it is possible to weaken the intensity of the contact effect using special devices for loading parts (grids, plexiglass containers, etc., handles with an elastic coating). If necessary, it is recommended to use short-term contact clamps, clamps, rubber and cotton gloves from time to time.

Walls and welding machines must have special devices for fixing parts during processing. Ultrasound - elastic vibrations with a frequency higher than the range of human hearing (20 kHz), propagates in the form of waves in gases, liquids and solids, or creates standing waves in limited areas of this medium.

Ultrasound sources - all types of ultrasonic technological equipment, ultrasound devices and equipment for industrial and medical purposes. Normalized parameters of contact ultrasound according to CH 9-87 PE 98, sound pressure levels in a third octave with geometric mean frequencies equal to 12.5; 16.0; 20.0; 25.0; 31.5; 40.0; 50.0; 63.0; 80.0; 100.0 kHz. Harmful effects of ultrasound are manifested in the functional disorders of the nervous system, changes in blood pressure, composition and properties of the human body. Workers complain of headaches, fatigue and hearing loss.

The main documents regulating safety when working with ultrasound GOST 12.1.001-89 SSBT "Ultrasound. General safety requirements" and GOST 12.2.051-80 SSBT "Technological ultrasound equipment. Safety Requirements", also SI 9-87 RB 98 "Airborne Ultrasound. Maximum permissible levels in workplaces", SI 9- 88 RB 98 "Ultrasound transmitted by contact. Maximum levels allowed in workplaces".

It is forbidden for a person to have direct contact with the working surface of the ultrasound source and the communication device during the ultrasound excitation. It is recommended to use a remote control; interlocks that ensure automatic shutdown when sound-proofing devices are opened. High-frequency ultrasound is almost invisible in air and can affect workers mainly when the ultrasound source comes into contact with the exposed surface of the body. Low-frequency ultrasound, on the other hand, has a general effect on workers through the air, and a local effect due to the contact of the hands with the workpieces, where the ultrasonic vibrations are excited.

Ultrasonic vibrations propagate in the direction directly at the source of formation, but at a small distance from the source (25-50 cm) they turn into concentric waves and fill the entire working room with ultrasound and high-frequency noise.

**Ultrasound has a significant effect on the human body.** As mentioned above, ultrasound can propagate in all media: gaseous, liquid and solid. Therefore, in the human body, it affects not only the actual organs and tissues, but also cells and other fluids. When

propagating in a liquid medium, ultrasound causes cavitation of this liquid, i.e. it is the appearance of the smallest empty bubbles filled with vapors of this liquid and substances dissolved in it and their compression (collapse). This process is accompanied by the formation of noise.

When working on powerful ultrasonic devices, operators complain of headaches, which, as a rule, disappear when work is stopped; quick fatigue; night sleep disorder; feeling of unbearable sleepiness during the day; weakening of vision, feeling of pressure on the eyelids; poor appetite; constant dryness in the mouth and stiffness of the tongue; abdominal pain, etc.

*infrasound* - the field of acoustic vibrations in the frequency range below 20 Hz. In production conditions, infrasound, as a rule, is combined with low-frequency noise, and in some cases with low-frequency vibration. Infrasound is absorbed very little in air and therefore can travel long distances.

Many natural phenomena (earthquakes, volcanic eruptions, sea storms) are accompanied by the emission of infrasonic vibrations.

In industrial conditions, infrasound is mainly generated during the operation of large-sized machines and mechanisms (compressors, diesel engines, electric locomotives, fans, turbines, jet engines, etc.) that perform rotation or rotational movement with cycle repetition, and operate at low speeds. Infrasounds of aerodynamic origin occur in turbulent processes in gas or liquid flows. According to SanPiN 2.2.412.1.8.10-35-2002 normalized parameters of continuous infrasound sound pressure levels in the octave frequency range with geometric mean frequencies of 2, 4, 8, 16 Hz.

The total sound pressure level is the value calculated by the energy sum of the sound pressure levels in the octave frequency bands, measured when the "linear" (from 2 Hz) frequency response is turned on in the sound level meter, or without corrective corrections; It is measured in dB (decibels) and denoted by dB Lin.

Infrasound has a negative effect on the entire human body, including the hearing organ, and reduces hearing sensitivity at all frequencies. The long-term impact of infrasound vibrations on the human body is considered a physical burden and causes fatigue, headaches, vestibular disorders, sleep disorders, mental disorders, central nervous system dysfunction, etc. Low-frequency vibrations with an infrasonic pressure level above 150 dB are absolutely unbearable for people.

## Conclusion

Compressors are the most characteristic and common source of low acoustic vibrations. It is noted that the noise of compressor shops is low-frequency and infrasound dominates, and in the operators' cabins, infrasound is more evident due to the attenuation of high-frequency noise. Powerful ventilation systems and air conditioning systems are also sources of infrasonic vibration. Their maximum sound pressure levels reach 106 dB at 20 Hz, 98 dB at 4 Hz, and 85 dB at 2 and 8 Hz, respectively.

In the frequency range of 16-30 Hz, the threshold of perception of infrasonic vibrations for a hearing analyzer is 80-120 dBA, and the threshold of pain is 130-140 dBA. The impact of infrasound on a person is considered a physical burden: spatial orientation is disturbed, seasickness, indigestion, visual disturbances, dizziness and changes in peripheral blood circulation. The degree of exposure depends on the frequency range, sound pressure level and duration of exposure. Vibrations with a frequency of 7 Hz interfere with concentration and cause fatigue, headaches and nausea. The most dangerous vibrations with a frequency of 8

Hz. They can cause the phenomenon of resonance of the circulatory system, which leads to an overload of the heart muscle, a heart attack, or even the rupture of some blood vessels. Low-intensity infrasound increases nervousness, can cause depression. Ultrasonic equipment and technologies are widely used in various fields of human activity for active exposure to substances (welding, tinning, processing, degreasing of parts, etc.); systematic analysis and control of physical and mechanical properties of substances and materials (defectoscopy); for processing and transmission of radar and computer signals; in medicine, sound images for the diagnosis and treatment of various diseases, cutting and combining biological tissues, sterilization instruments, hands, etc.

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***Rezyume:*** *Ultratovushning eng keng tarqalgan manbalari piezoelektrik va magnit transduserlardir. Bundan tashqari, ishlab chiqarish sharoitida past chastotali ultratovush ko'pincha aerodinamik jarayonlarda hosil bo'ladi: reaktiv dvigatellarning ishlashi, gaz turbinalari, kuchli pnevmatik motorlar va boshqalar. Ultratovush- bu elastik muhitning mexanik tebranishlari, unda o'zgaruvchan siqilishlar va siyraklanishlar shaklida tarqaladi; 16-20 kHz dan yuqori chastotalisi inson qulog'i bilan sezmaydi. Ultrasonik tebranishlar chastotasining oshishi bilan ularning muhit tomonidan so'rilishi oshadi va inson to'qimalariga kirish chuqurligi pasayadi. Ultratovushning yutilishi muhitni isitish bilan birga keladi. Ultratovushning suyuqlikdagi o'tishi kavitatsiya ta'siri bilan birga keladi.*

***Резюме:*** *Наиболее распространенными источниками ультразвука являются пьезоэлектрические и магнитные преобразователи. Кроме того, в производственных условиях низкочастотный ультразвук часто генерируется при аэродинамических процессах: работе реактивных двигателей, газовых турбин, мощных пневмодвигателей и т.п. Ультразвук — механическая вибрация упругой среды, распространяющаяся в виде попеременных сжатий и разрежений; Частота выше 16-20 кГц не воспринимается человеческим ухом. По мере увеличения частоты ультразвуковых колебаний увеличивается их поглощение окружающей средой и уменьшается глубина проникновения в ткани человека. Поглощение ультразвука сопровождается нагревом окружающей среды. Прохождение ультразвука в жидкости сопровождается эффектом кавитации.*

***Ключевые слова:*** *ультразвук, пьезоэлектрические и магнитные преобразователи, воздействие на дыхательные пути.*

***Kalit so'zlar:*** *ultratovush, pyezoelektrik va magnit transduserlar, havo yo'llarining ta'siri*