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Кафедра общей гигиены, экологии и радиационной медицины

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ГИГИЕНА ТРУДА

Учебно-методическое пособие
для студентов 3 курса
факультета по подготовке специалистов для зарубежных стран,
обучающихся на английском языке,
медицинских вузов

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OCCUPATIONAL HYGIENE

The educational methodical work
for 3th year students
of the Faculty of preparation of experts
for foreign countries educated in English
of medical higher educational institutions

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Учебно-методическое пособие состоит из 3-х взаимосвязанных разделов и посвящено изучению гигиены труда, рассчитано на 12 часов практических занятий. Первый раздел называется «Гигиена и физиология труда. Принципы и методы оценки функционального состояния организма при различных видах труда. Исследование утомления. Оценка тяжести и напряженности труда», второй — «Характеристика профессий, связанных с воздействием физических факторов. Профилактика заболеваний», третий — «Характеристика профессий, связанных с воздействием промышленных ядов. Профилактика отравлений». Учебно-методическое пособие соответствует требованиям высшей школы.

Предназначено для студентов 3 курса факультета по подготовке специалистов для зарубежных стран, обучающихся на английском языке, медицинских вузов.

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TOPIC I
HYGIENE AND PHYSIOLOGY OF WORK. PRINCIPLES AND METHODS OF EVALUATION OF ORGANISM FUNCTIONAL CONDITION AT VARIOUS WORK KINDS. FATIGUE RESEARCH. ESTIMATION OF WEIGHT AND WORK INTENSITY

Urgency of a theme:

The estimation of working conditions, besides studying of industrial environment condition (parameters of a microclimate, a dust content, a gassed condition, noise level, vibration, illumination, etc.) should include, as a rule, also carrying out of physiological researches. The purpose of them are definition of functional shifts in organs and organism systems during work for an estimation of workability in dynamics for the working day, an exhaustion degree and development of rational work and rest modes with an estimation of their efficiency after introduction.

The purpose:

To master methods of workability estimation with functional condition parameters, to reveal dynamics of workability and to give recommendations on exhaustion decrease.

Practical skills:

To be able to carry out researches of organism functional condition in process of work activity, to estimate workability and to give the recommendations on exhaustion reduction.

Tasks:

1. To master the practical skills on estimation of carrying out functional organism condition during work activity.
2. To learn to assess the degree of weight and work intensity on ergometric and physiological parameters and to give the recommendations on work rationalization.
3. To learn to estimate the workability and to give the recommendations on exhaustion decrease.

Requirements to initial level of knowledge

To repeat from:

1. Normal physiology — topics: «Methods of physiological functions research and workability of the man», «Basic functions of physiological systems and their role in maintenance of organism live ability and its mutual relations with environment, «Physiological shifts in an organism in various conditions of work activity».
2. Pathological physiology — «Physiological shifts in a functional condition of various organs and die systems, connected to physical overload».

Control questions from adjacent subjects:

1. What methods of research are applied for functional condition estimation?
2. To give estimation to physiological changes of human workability?
3. What physiological infringements can arise at the person at physical loading?

The basic educational questions:

1. Classification of work kinds. The working conditions.
2. Factors of the irrational work organization as occupational hazard.
3. Functional shifts in an organism at work.
4. Classification of organism functional conditions.
5. The physiological characteristic of workability dynamics, its phases. Fatigue and over fatigue.
6. An estimation of weight and work intensity.
7. Measures of fatigue and over fatigue prophylaxis, value of active rest.
8. An overstrain of separate organs and systems, prophylaxis of the diseases connected to them.

Materials for study maintenance

Stop watches, stethoscopes, tonometer, scales, auxanometer, centimeter tape, chronoreflexometer, tremometer, correction tables, tests.

Tables № 7, 51, 66, 71, 73.

Tasks for self-preparation and research student's work

The decision of situational tasks.

Research of organism functional condition, research and estimation of workability, recommendations at fatigue decrease.

Performance of reports on themes:

«Techniques of research and an estimation of professional workability».

«Diagnostics of fatigue and overfatigue».

THE ADDITIONAL INFORMATION TO TOPIC

B dependence on the basic characteristics and the physiological requirements showed to an organism can distinguish the following kinds of labour activity:

1. Work physical, demanding significant muscular activity, big energy expenses and a primary extension of vegetative organism functions. Physical work can be dynamic and static.
2. The mechanized work connected to service of various machine tools and mechanisms.
3. The automated work.
4. Conveyor, or the group work, connected to products moving on to course of its processing from one worker to another.
5. The intellectual work connected to reception and processing of the information and demanding a primary pressure of the maximal nervous (mental) activity.

Classification of danserous and harmful production factors:

1. Psychophysiological factors in the organization of work, the device of a workplace and the equipment, service of machines, mechanisms, systems:

a) physical (static and dynamic) overloads of the locomotor device: rise and carry of the weights, inconvenient position of a body, long pressure upon a skin, joints, muscles and bones;

b) physically insufficient impellent activity (hypodynamia and hypokinesia);

c) physiological overloads of bodies of blood circulation, breath, vocal chords;

d) psychological overloads: an intellectual pressure, emotional overloads, overstrain of analyzers, monotony of work.

2. Physical production factors.

a) the increased and lowered temperature, humidity, air mobility of a working zone;

b) the increased level of infra-red radiation;

c) the increased level of ultra-violet radiation;

d) fhe increased level of monochromatic (laser) radiation;

e) the increased level of ionizing radiation;

f) the increased level of electromagnetic radiation, electric-and-magnetic field intensity;

g) the increased level of a static electricity;

h) the increased dust content in air of a working zone;

i) the increased noise level, vibration, ultrasound and infrasonic fluctuations;

k) insufficient light exposure or irrational illumination of a working zone;

l) the increased or lowered atmospheric pressure.

3. Chemical production factors: gases, vapor, liquids, the aerosols rendering general toxic, irritating, sensitizing, cancerogenic, mutagen action, influence on reproductive function.

4. Biological production factors.

a) micro- and macroorganisms — sources of infection, invasion, fungous diseases;

b) vitamins, hormones, antibiotics, substances of the albuminous nature.

5. Danger of industrial traumas.

6. Social-and-economic factors.

Working conditions

Set of factors of the industrial environment, influencing on health and workability of the person during work.

Dangerous and harmful working conditions are submitted according to their classification: physical, chemical, biological, etc.

Those one, which action on workers in the certain conditions can result in disease or stable workability decrease are considered as **harmful production factors.**

The **dangerous production factors** are the working factors, which action in the certain conditions can result in a trauma or other sudden sharp health deterioration.

Hygienic classification of work

1 class — optimum conditions and character of work at which adverse influence on health of working dangerous and harmful production factors is excluded, are created preconditions for preservation of a high level workability.

2 class — maximum-permissible conditions and character of work at which adverse factors do not exceed hygienic specifications on workplaces, do not result to fatigue cumulation and during the seniority do not result in a trauma, disease or a deviation in health state during work or in the remote terms of life of the present and the subsequent generations.

3 class — harmful both dangerous conditions and character of work, at which owing to infringement of sanitary norms and rules probably influence of adverse factors of the industrial environment in the values exceeding hygienic specifications and psychophysiological of factors of work activity, causing functional organism shifts which can result in stable infringement of workability or health working.

In 3-rd class three degrees of harmful and dangerous conditions and character of work are allocated.

1 degree — conditions and character of the work, causing functional infringements which influences after the termination have convertible character (limiting — tolerable working conditions).

2 degree — conditions and character of the work, the causing stable functional infringements promoting growth of morbidity parameters with temporary disability and to occurrence of attributes and easy forms of occupational diseases.

3 degree — conditions and character of work with the raised danger of occupational diseases development, the raised morbidity with temporary disability.

Estimation of weight and work intensity

Weight of work — the characteristic of labour process reflecting basically loading on the musculoskeletal system and functional systems (cardiovascular, respiratory, etc.), providing its activity.

Intensity of work — the characteristic of labour process reflecting primary loading on the central nervous system, i.e. is determined nervous, psycho emotional tension, duration and intensity of intellectual loading.

The similar division of labour (heavy and intense) is conditional, as physical work is necessarily accompanied by loading on CNS and on the contrary, intellectual work — a muscular component (for example, support of a working pose), and static work is more tiresome, than dynamic since the pressure of muscles (sitting, standing) lasts continuously and vessels in them are squeezed, that complicates normal blood circulation and results in blood stagnation, accumulation suboxided products.

For work classification on a degree of weight and intensity are used qualitative and quantity indicators.

To quality indicators concern:

1. Subjective (complaints to exhaustion, etc.).
2. Social (turnover of staff).

3. Technical and economic (spoilage, labour productivity, etc.).

4. Medical and biologic (health state of work collective, morbidity, etc.).

Among quantity indicators are allocated:

1. Physiological, i. e. parameters of proceeding physiological organism reactions in work and after performance of work activity.

2. Ergometric, i. e. the parameters describing quantity of executed work.

For example, estimation criteria of work weight are: weight of a moved cargo (kg), work capacity (Wt), size of dynamic static physical loading per shift (kg/m), number of movements in one hour, movements in space per shift (km), a pulse rate, energy expenses (kJ/mines), etc.

Estimation criteria of work intensity are: density of signals, messages on the average per hour, number of simultaneously observable objects, duration of the concentrated supervision (%, time of shift), visual tension, hearing, volume of operative memory, an emotional tension.

Additional criteria of work monotony, the schedule of workers in shift can be, etc.

Classification of work on a degree of weight and work intensity

1 category — easy, not intense.

2 category — average, low-intensive.

3 category — heavy, intense.

4 category — very heavy, very intense.

Criteria of weight and work intensity estimation on ergometric and physiological parameters

Parameters	**Quantitative criteria of work**			
	easy, non-intense	**average, low-intense**	**heavy, intense**	**very heavy, very intense**
Ergometric				
The maximal weight relocatable cargo, kg	Up to 5	6–10	11–30	> 30
Size of dynamic physical loading, per shift, kgm: — General — men — women	 >> 62500 >> 37500	 Up to 104000 Up to 62400	 > 104000 > 62400	 —
— Regional — men — women	 >> 31500 >> 18900	 Up to 52000 >> 31200	 >> 52000 >> 31200	 —
— Local — men — woman	 >> 6100 >> 3660	 >> 10250 >> 6150	 >> 10250 >> 6150	 —
Weight of manual goods turnover per shift at rise of cargo, ton — from working surface — from a floor	 >> 10 >> 4	 >> 12 >> 5	 >> 15 >> 6	 >> 15 >> 6
Capacity of external work at: — general work, Wt — regional, Wt — local, Wt	 >> 20 >> 10 >> 2	 >> 45 >> 22 >> 4,5	 >> 90 >> 45 >> 9	 >> 90 >> 45 >> 9

Parameters	Quantitative criteria of work			
	easy, non-intense	**average, low-intense**	**heavy, intense**	**very heavy, very intense**
Ergometric				
Number of movements during one hour	>> 270	>> 360	>> 1080	Up to 3000
Density of signals, messages on the average in one hour	>> 75	>> 175	>> 300	> 300
Monotony: — number of elements in operation — duration of performance operation, sec	 More than 10 >> 100	 10–6 100–46	 6–3 45–20	 3–2 20–2
Movements in space per shift, km		Up to 4	Up to 7	From above 7
Duration of the concentrated supervision: (% of time in work shift)	Up to 25 %	25–50 %	50–75 %	Over 75 %
Number of industrial important objects of supervision	Up to 5	5–10	10–25	From above 25
Physiological				
Energy expenses, kJ min	Up to 10,5	>> 21,0	>> 31,5	More than 31,5
Pulse rate, bits/min	90,0	100,0	120,0	>> 120,0
Endurance (reduction to initial, %)	20,0	30.0	40,0	>> 40,0
Lengthening of reaction time to light or sound (to initial, %)	5–10	20–30	40–50	60–70
Reduction of critical frequency of light flashings, %	0–12	12–13	19–22	From above 22
Reduction of movements at the teping-test, %	0–7	8–17	18–27	From above 28
Increase in frequenty of intimate reductions, bit/min	0–1	1,5–19	20–37	From above 37

Classification of organism functional conditions

The functional organism condition is a complex system reaction of the individual to influence of factors of the external and internal environment during labour activity. The functional condition is a set of available characteristics of those its functions and qualities which in many respects cause success of professional work.

To a basis of the general classification of functional conditions of the man two basic criteria lay: **reliability and the value of activity.**

Reliability is understood as probability of tasks performance in view of professional work in the set parameters.

The value of activity (physiological working costs) is a size physiological and psychophysiologic expenses, providing work performance at the set level.

All functional conditions share on three basic classes: normal, border and pathological.

To **normal functional conditions** concern thase, at which the set level of work, and it psychophysiologic value is kept as adequate to homeostasis parameters. All regulator mechanisms are in a physiological optimum in organism, the condition of physiological rest, the condition of satisfactory organism adaptation.

Border functional conditions are characterized by reduced reliability of professional work, or psychophysiological cost inadequacy. In a basis of formation and development of **border functional conditions** lay disturbance of regulator mechanisms, which long time can not be reflected in a health state and workability. These conditions are divided into **allowable and inadmissible functional conditions.**

If at border functional condition work reliability is reduced in allowable limits, and the cost of activity corresponds to a constancy of the internal environment of an organism, these conditions can be considered **allowable.** Physiological mechanisms of adaptation are in a condition of some tension (organism is in a **pre-nozologic** condition on a health level).

Those border functional condition, at which or work reliability is below then norm, or the activity cost is inadequate to homeostasis parameters, belong to **inadmissible,** the condition of unsatisfactory adaptation of physiological mechanisms (regulator and power) is marked here. A level of health — **premorbid conditions (subclinical stages of disease).**

At pathological functional conditions necessary reliability of work is not provided, and the cost of activity exceeds homeostasis opportunities. This is condition of failure of adaptation mechanisms.

For example, the **chronic exhaustion** is a border condition in relation to **overfatigue** — pathological condition.

The exhaustion is the normal functional condition, arising in process of work, which is characterized by sensation of weariness, deterioration of organism function, decrease of workability and disappearance of these attributes after regulated rest.

The chronic exhaustion is a boundary functional condition, which is characterized by preservation to the beginning of the next work cycle of subjective and objective exhaustion attributes from the previous work, for which liquidation additional rest is necessary.

The basic attributes of chronic exhaustion are sensation of weariness before the beginning of work, fast fatigue, the undue fatiguability, the raised irritability, often changes of the mood, the expressed deterioration of organism functions and reduction of professional workability.

Overfatigue is a pathological functional condition of an organism, for which normalization is necessary not only additional rest, but special treatment also.

Overfatigue is characterized by constant sensation of weariness, slackness, infringements of sleeping, appetite disappearance, hostility to the work, unpleasant sensations in the field of heart, pains in various body parts. To objective attributes of overfatigue concern raised hyperhidrosis, a short breath, reduction of body weight, increase of frequency of intimate reductions, frustration of attention, memory and thinking. The main objective criterion of overfatigue is sharp reduction of professional workability.

The condition caused monotonous, results from action of the same limited set irritators, causing monotonous stereotyped reactions. At monotony it is ob-

served wavy dynamics of the professional work, which has been not connected to an exhaustion of organism resources. The condition caused monotony, is accompanied fast reduction of positive working motivation can result in development mental satiation also. And so, characteristic attributes of drowsiness and irritability arise at monotony, as result of mental satiation.

Psychoemocional tension is the condition described adequate expressiveness of the emotional reactions directed on mobilization of functions for successful performance of professional work.

Psychoemocional intensity — a condition described excessive expressiveness of the emotional reactions, interfering adequacy of professional work of its physiological value. The syndrome of psychoemocional intensity is allocated, describing with five basic attributes:

1. Clinical — personal and reactivity uneasiness.
2. Psychological — decrease of a self-estimation and a level of social adaptation.
3. Physiological — prevalence of a sympathetic nervous system tone above para-sympathetic.
4. Endocrine — increase of activity sympathenic-adrenal and hypothalamic-pituitary-adrenal system.
5. Metabolic — increase of fat transport forms in blood, change of lipoprotein spectrum aside atherogenic fractions.

This is border functional condition, which can result to mental and psychosomatic pathologies development (neurosis, ulcer of a stomach and a duodenal gut, myocardial ischemia, arterial hypertension, etc.).

Shifts of a functional condition during performance of professional work pass some stages or phases, which are designated as a stages of workability dynamics:

1. Prolong.
2. High workability.
3. Full indemnification.
4. Unstable indemnification.
5. Progressive decrease of work success.
6. A final impulse.

It is expedient to allocate two more: preparatory and regenerative. The estimation of workability includes stages:

1. Estimation of a subjective condition.
2. Estimation of intellectual workability.
3. Estimation of physical workability.
4. Estimation of professional workability.
5. Diagnostics of fatigue and overfatigue.
6. Forecasting of workability shifts.
7. The conclusion about a condition and shifts of workability.

Research of a functional condition of human organism

To supervise adverse dynamics of a functional condition, the integrated parameter is offered to students — Index of functional shifts (IFS).

$$IFS = 0{,}011 \times PR + 0{,}014 \times SP + 0{,}008 \times DP + 0{,}014 \times A + \\ + 0{,}005 \times BM - 0{,}5009 \times H - 0{,}27,$$

where: PR — pulse rate per one minute;

SP and DP — accordingly, systolic and diastolic pressure (mm. Hg);

BM — body mass (kg);

II — height (cm);

A — age (years).

Value IFS is in limits from 1,00 up to 4,00. Conditional borders of values for various groups of health are:

1. Satisfactory adaptation — up to 2,59.
2. Tension of adaptation mechanisms — from 2,66 up to 3,09.
3. Unsatisfactory adaptation — from 3,10 up to 3,49.
4. Breaking of adaptation — more than 3,50.

Research and estimation of workability

The estimation of a subjective condition of students is given on parameters, characterizing three categories of attributes: health state, activity and mood, (SAM) which are defined with the help of a test card.

Test SAM

1	Health State is good	3	2		0	1	2	3	Health state isbad
2	I feel strong	3	2		0	1	2	3	I feel weak
3	Passive	3	2		0	1	2	3	Active
4	Inactive	3	2		0	1	2	3	Mobile
5	Cheerful	3	2		0	1	2	3	Sad
6	Good mood	3	2		0	1	2	3	Bad mood
7	Efficient	3	2		0	1	2	3	Broken
8	Full of forces	3	2		0	1	2	3	Weakened
9	Sluggish	3	2		0	1	2	3	Fast
10	Inactive	3	2		0	1	2	3	Active
11	Happy	3	2		0	1	2	3	Unfortunate
12	Cheerful	3	2		0	1	2	3	Gloomy
13	Intense	3	2		0	1	2	3	Weakened
14	Healthy	3	2		0	1	2	3	Sick
15	Indifferent	3	2		0	1	2	3	Keen
16	Indifferent	3	2		0	1	2	3	Excited
17	Enthusiastic	3	2		0	1	2	3	Sad
18	Joyful	3	2		0	1	2	3	Sad
19	Had a rest	3	2		0	1	2	3	Tired
20	Fresh	3	2		0	1	2	3	Exhausted
21	Sleepy	3	2		0	1	2	3	Excited
22	Desire to have a rest	3	2		0	1	2	3	Desire to work
23	Quiet	3	2		0	1	2	3	Anxious

24	Optimistic	3	2		0	1	2	3	Pessimistic
25	Hardy	3	2		0	1	2	3	Tired
26	Vigorous	3	2		0	1	2	3	Inert
27	To think difficultly	3	2		0	1	2	3	To think easily
28	Absent-minded	3	2		0	1	2	3	Attentive
29	Full of hopes	3	2		0	1	2	3	Disappointed
30	Self-satisfied	3	2		0	1	2	3	Dissatisfied

Impending on judgment value at surveyed conditions are marked by expressiveness degree of this or that attribute on seven-ball scale.

Attributes under numbers characterize:

1–2, 7–8, 13–14, 19–20, 25–26 — health state;

3–4, 9–10, 15–16, 21–22, 27–28 — activity;

5–6, 11–12, 17–18, 23–24, 29–30 — mood.

The average arithmetic size is the direct subjective characteristic of workability.

The increase in a difference between these parameters more than 0,6 points in comparison with the initial data can testify' shift of a functional condition and workability decrease.

Normative parameters of a subjective condition are: health state — 6,1 ± 0,1, activity — 5, 3 ± 0,1, mood — 5,7 ±0,2.

Estimation of intellectual workability

Basic characteristics of higher nervous activity at intellectual work are psychophysiologic qualities and mental processes.

Psychophysiologic qualities are properties of nervous system and analyzers functionalities. Researches are carried out with the help of the following techniques:

1. Simple sensomotor reaction (SSMR) characterizes force of nervous processes. To estimation SSMR are applied reflexometer. The normal reaction makes 140–180 ms.

2. Complex sensomotor reaction on light irretants (CSMR) characterizes mobility of the basic nervous processes (CSMR with a differentiation). Time makes 270–330 ms in norm.

3. Reaction for moving object (RMO) characterizes steadiness of excitation and braking processes in a bark of brain. Reaction can be counted enough exact, if relative frequently of exact responses makes 16 % and more.

4. Critical frequency of mergers of light flashings (CMLF) allows to estimate mobility of nervous processes in the visual analyzer.

5. Critical frequency of mergers of sound fluctuations is used for definitions of acoustic analyzer functional condition.

6. Functionalities of locomotor analyzer allows to estimate teping-test, and also force of excitation process and basic nervous processes mobility.

Productivity of 260–230 points for 40 sek. is estimated «excellent», 229–200 — «good», 199–170 — «satisfactory».

7. Tremorometry characterizes ability to thin moving coordination and mobility of nervous processes in impellent analyzer. It is carried out by registration of involuntary tremblings of hands.

Average size of contacts quantity per 1 sek. At dynamic test shifts from 1,9 up to 2,3, at static test — from 0,5 up to 1,0.

To professionally important mental processes at intellectual activity concern recognition, memory, attention, thinking and emotions.

At research of mental processes are used next methods:

1. The perception can be appreciated by the help of a technique «the Reflex for a while».

2. Short-term memory is investigated in visual and acoustical variants. In visual — with the help of the special table with 12 two-digit numbers, which are showed to examinees during 30 sek.

In acoustical — 10–12 words will become engrossed in reading. Result «perfectly» — at reproduction more than 8 numbers (words), «good» — 6–8 numbers (words), satisfactory — 4–5 numbers (words).

3. Researches of long-term memory are made by repeated recurrences of 10 same words (numbers), which have been not connected on semantic meaning. Results are considered «good», if memorizing speed is 2 repetitions, and volume of long-term memory — 5.

4. For research of operative memory is applied presentation technique of 10 numerical series. The probationer should memorize delivered numerical series and to write down the sums from addition of the first with the second, thesecond the third, etc. On the decision it is given 15 sek.

5. The attention is characterized by volume, distribution, concentration, stability and switching.

For research of attention stability it is used test with Landolt rings, V. J. Anfimov tables and Platonov in figures or letters.

6. For an estimation of thinking techniques can be used «mental arithmetic» and «Count of numbers with switching».

During 1 min is necessary quickly and correctly mentally to add to the received sums the same number 18.

The average of additions makes 15–18 in 1 min at 1–2 mistakes.

7. Emotions on their importance for ability to live are shared on sthenic and asthenic.

The emotions, promoting internal rise, mobilized will, raising activity and vivacity giving energy, self-reliance to the person are considered sthenic.

The emotions, weakening activity, lowering workability and oppressive mood of the person, refer to asthenic.

For the characteristic of an emotional condition are used techniques: skin-galvanic reaction, measurement of frequency head reductions and arterial pressure, questionnaires Isek, Spielberger-Hanin, Taylor, etc.

Estimation of physical workability

Abilities to perform the work connected to physical are estimated efforts and primary tension of vegetative functions. It characterized by aerobic and anaerobic organism opportunities.

— The maximal oxygen consumption — by direct and undirect methods.

— The index of the step-test is defined.

— Are investigated anaerobic organism opportunities, etc.

Estimation of professional workability

The quantitative estimation of workability shifts is characterized by one integrated size uniting separate parameters with the account of their importance. It can be designed with the help following formula:

$$A = W_1 \frac{a_1}{a_0} + W_2 \frac{B_1}{B_0} + W_3 \frac{c_1}{c_2} + \ldots W_n \frac{n_1}{n_2}$$

If initial value (Ao) of workability integrated parameter equal 1 that in time t it has decreased on:

$$(\text{Ao} - \text{A}) \times 100\ \%$$

If this value (Ao) worsens more than on 19 %, that corresponding to it the condition of professional work cannot be counted normal. Such degree of deterioration of organism functional condition testifies to developing overfatigue (or other pathology).

Practical work

The task 1. To solve a situational task according to a degree of weight and work intensity on ergometric and physiological parameters.

The task 2. To give recommendations on improvement and rationalization of work.

The task 3. To issue results as the report.

TASK № 1

Assembler of electro-ceramic products has stationary working place, working pose — sitting, free. She works in two shifts. Maximal weight of a moved cargo — 3 kg. Number of movements during one hour — 300.

Duration of the concentrated supervision — 27 %. Energy expenses per shift on the average it was equaled 11,2 kJ/min. Pulse rate on the average per shift — 84 bit/min. Muscular endurance in the beginning of shift — 17,6 s., and in the end — 19,1 s. Time of numbers finding in the beginning of shift — 79,4 s., in the end — 87,5 s.

To define a degree of weight and work intensity. What criteria are used for hygienic estimation of work? To give recommendations on organization of a rational work and rest mode.

TASK № 2

The laboratory doctor has a stationary workplace, pose — sitting, the compelled inclinations (a corner of an inclination up to 30°) during 25 % working hours.

She works in 1 shift. The maximal weight of a moved cargo — 3 kg. Movements number per one hour — 270. Number of elements in operation — 7, duration of operation — 52 s. Duration of the concentrated supervision — 35%. Average energy expenses — 22 kJ/min. A pulse rate — 98 bits/min. Prolongation of reaction time on sound irritant in the beginning of shift — 25 %. To define a degree of weight and work intensity. What criteria are used for hygienic estimation of work? To give recommendations on correct of work organization.

TASK № 3

The loader of railway station works in 3 shifts (one — night).

Workplace is non-stationary. The maximal weight of a moved cargo 35–50 kg. Size of a manual turnover of goods per shift at rise of cargoes from floor 6 tons.

Average displacement in space per shift — 8 kms. Energy expenses — 35 kJ/min. A pulse rate — 125 bit/mm, increase intimate reductions — 38 bit/min. Muscular endurance in the beginning of shift — 18 s., in the end — 35 s.

To define a degree of weight and work intensity. What criteria are used for hygienic estimation of work? To give recommendations on correct organization of work and rest.

TOPIC II
CHARACTERISTIC OF THE TRADES CONNECTED TO INFLUENCE OF PHYSICAL FACTORS. PROPHYLAXIS OF DISEASES

Total time — 4 hours

URGENCY:

Scientific and technical progress is based on mechanization of productions, increase in capacity and speeds of moving of the equipment, transport, introduction of new technology, including medicine, mechanical fluctuations accompanying with more intensive occurrence, radiation and other physical factors.

THE PURPOSES:

— To study mechanisms of influence on an organism of industrial factors of the physical nature;

— To familiarize with methods of measurement and a hygienic assessment of physical factors; applying the instructive materials reflecting questions of hygiene of work on the given theme;

— To learn to develop actions for decrease of adverse their influence on workers.

PRACTICAL SKILLS:

1. To learn to draw the conclusion about conformity of the specified production factors to norms and probable character of their influence on an organism.

2. To seize practical skills on measurement of the general noise level with the help noise dosimeter and to be able to estimate the received results.

REQUIREMENTS TO THE INITIAL KNOWLEDGE LEVEL

It is necessary to repeat from:

1. Normal physiology — themes: «Physiological condition of an organism at influence of various environmental factors», «Adaptation of the person to influence of environmental factors».

2. Pathological physiology — a theme «Pathogenic action of environmental factors».

3. Medical and biological physics — themes: «Mechanical oscillatory and wave processes, their characteristic, methods of research». «Optical methods of research and influence of optical range radiation on biological objects».

CONTROL QUESTIONS FROM RELATED SUBJECTS

1. What does represent noise from the physical point of view? Characteristics of noise.

2. Name units of noise measurements and their substantiation.

3. What physical characteristic of vibration?

4.What physiological methods of research are applied for estimation of health state of worker, exposed to noise influence?

5.What physiological methods of research are applied for estimation of worker's health state, exposed to influence of vibration?

THE BASIC EDUCATIONAL QUESTIONS

1. Noise, its hygienic characteristic, classification. Noise action on organism, prophylaxis of adverse influence. Hygienic standardization and measurement of noise.

2. Vibration, local and the general, their hygienic characteristic. Measurement and standardization. Action on organism, prophylaxis of harmful action of vibration.

3. A microclimate. The characteristic of conditions of heat exchange in working premises. Prophylaxis of infringements of heat exchange.

4. Requirements to light exposure and color registration of interiors of industrial premises.

5. Mode of work and rest, influence of a mode on health, workability and psychological condition.

6. Dust, classification. Definition of a dust concentration in air and a hygienic assessment the dust pathology and the basic directions for dust diseases prophylaxis.

TEACHING MAINTENANCE

Demonstrable tables № 55, 52, 64.

THE TASK FOR SELF-PREPARATION

— To solve situational tasks.

— To familiarize with devices and methods of a hygienic noise estimation, vibration, illumination, microclimate on manufacture.

— To familiarize with a weight method of dust concentration research in air on workplaces and definition of dust dispersiveness.

— To execute abstracts on themes: «Ultrasound and infrasound, prophylaxis of adverse influence on an organism».

— «Infra-red radiation, action on organism, prophylaxis of adverse influence».

«Carrying out of researches according to an industrial microclimate and its action on an organism».

AUXILIARY MATERIALS

Noise is a set of different intensity and the frequency sounds, randomly changing in time, arising under industrial conditions and causing at workers unpleasant sensation and objective changes of organs and systems. From the physical point of view sounds represent extending mechanical oscillatory movements in an audible range of frequencies. Mechanical fluctuations are characterized by **amplitude and frequency.** Amplitude is the greatest size of pressure change at impactions and underpressures. Frequency is number of full fluctuations per l sek. Unit of measurement is hertz — one fluctuation per a second.

The amplitude of fluctuations determines size of pressure and force, intensity of sounding: then it is more, the more sound pressure and a sound is louder. Sound pressure is measured in bars. A bar — one million part of atmospheric pressure or the pressure equal 1 mg/cm^2. The sound wave carries the certain mechanical energy measured in watts on 1 cm^2.

At sounds perception the ear plays a role of a sensitive monometer. There are upper and low limits of ear sensitivity. The low limit — a threshold of hearing corresponds approximately to pressure 0,0002 bars, that on energy sound size equal 10–12 Wt/m^2. The big amplitude and sound wave energy causes unpleasant sensations and even a pain in ears. It is the upper limit of acoustical sensitivity that corresponds to pressure about 500–1000 bar or energy of 10^{-3} Wt/cm^2.

The second characteristic of a sound wave is **frequency** of extending fluctuations. It also influences acoustical perception, determining height of sounding.

Physiological feature of perception of sounds frequency structure is that the hearing reacts not on absolute, and on a relative gain of frequencies: the increase in frequency of fluctuations is twice perceived as increase of tone/pitch of tone/on the certain size named an octave.

Hence, an **octave** — a range of frequencies, in which upper border twice more, then low. All audible range of frequencies consist on 9 octaves with middle geometric frequency: 16, 31, 63, 125, 250, 500, 1000, 2000, 4000, 8000, 16000 Hz. For a hygienic estimation of noise practical interest represents a sound range of frequencies from 45 up to 11000 Hz.

At a hygienic assessment of noise measure its intensity/power/ are determined spectral structure on sounds frequency included in it. At measurement of sounds intensity would be possible to express results in sizes of absolute pressure / bar/ energy of a sound wave/watts per 1 cm^2, but for practical purposes it is inconvenient, because the range of audible sizes is very great: the low border is equal 10^{-16} Wt/cm^2, the upper 10^{-3} Wt/cm^2, i. e. the second size in 10^{13} times more to the first.

Besides at a choice of a measurement method of sound intensity is taken into account, that in sounds recognition on their force there is an important physiological feature: at increase in sound energy in 10 times on hearing it is felt as increase of loudness twice.

Gradation in perception and big energy band for measurement of sounds or noise intensity are used a logarithmic scale — so-called bel scale or decibel.

For initial mean «0» bel is «white» threshold size for hearing of sound energy of 10^{-16} Wt/cm^2 is accepted. At its increase in 10 times the sound is perceived as twice louder, intensity of it makes 1 bel. At intensity increase in 100 times in comparison with threshold, i.e. up to 10^{-14} Wt/cm^2, a sound it appears twice more loudly previous, and intensity of it is equal 2. Intensity in 1000 times more then threshold (10^{-13} Wt/cm^2) corresponds to the follow step — 3, in 10000 times — 4 bel, etc. In other words, at measurement of sounds intensity is used not absolute units of energy or pressure, and relative. The decimal logarithm of the attitude of energy or pressure size of the given sound to energy or the pressure sizes, being threshold for hearing, we receive sound intensity in bel. However the hearing perceives not only amplification of loudness twice, but also intermediate, smaller amplification, therefore at measurements is used unit, in 10 times smaller, than is bel, named decibel. Use this logarithmic scale is very convenient: all range of human hearing is stacked at 13–14 bel/130–140 dB.

Example: If sound intensity in absolute sizes is equal 10^{-9} Wt/cm^2, its relation to the hearing threshold equal of 10^{-16} Wt/cm^2 will make 10^{-9}, i. e. is equal 10 000 000. The logarithm, as is known, represents 10^{-16} degree in which erect the bases for reception of the necessary number. At decimal logarithms the basis is equal 10 and the size 10000000 can be presented as 10^{-7}, i. e. the logarithm in this case is equal 7. Hence, sound intensity is equal 7 bel or 70 dB.

But it is necessary to remember, that at comparative assessment different noise it is easy to make mistake if not to take into account logarithmic scale construction. There noise by intensity 60 dB is twice louder, than 50 dB, and noise by intensity 70 dB is twice louder, than 60 dB, and in 4 times is louder, than 50 dB though these sizes (50, 60, 70) numerically in decibels are close.

Depending on spectrum character is allocated the following noise:

— **Wide-band,** with uninterrupted spectrum in width more than one octave;

— **Tonal,** in spectrum which arc available audible discrete tones, exceeding levels in one octave strip in comparison with next not less than on 10 dB.

On time characteristics is distinguished the following noise:

— **Constant,** noise level during the 8-hour working day changes in time no more, than on 5 dB;

— **Non-constant,** noise level during the 8-hour working day changes in time not less than on 5 dB.

Changeable noise can be divided into the follow kinds:

— **Varying in time,** which level of a sound continuously changes in time;

— **Interrupted,** which sound level changes in steps (on 5 dB and more), and duration of intervals during which the level remains constant, makes 1 sek and more;

— **Impulse,** consisting of one or several sound signals, each of which duration less than 1 sek and levels of a sound thus differs not less, than on 7 dB.

Noise measurement on workplaces is made noise dosimeter-by 1-st or 2-nd classes of accuracy according to sanitary standard.

The guiding assessment of noise loudness can be made by a research method of speech discrimination. Against the background of a working source of noise (the person with good diction) says by a loud voice 50 4–5-place numbers, for example: 58345, 2487..., the others written down them, being on distance 1,5m from the announcer.

If from 50 numbers it is written correctly down not less than 40, it testifies to satisfactory speech discrimination, which is characteristic for the noise which is not exceeding an allowable level of loudness (table 1, 2).

Table 1 — Allowable levels of sound pressure, levels of the sound and equivalent levels of the sound on workplaces *(extraction from sanitary rules № 3233-85)*

№	Kind of work activity	Levels									Sound levels, dBA
		16	31,5	63	125	250	500	1000	2000	4000	
2	To laboratory for theoretic work and processing experimental data, for reception of patients	90	86	71	61	54	49	45	42	40	50
5	Performance of all kinds of work on constant work places in production premises	107	95	87	82	78	75	73	71	69	80

Table 2 — Optimum levels of the sound on work places for work of different categories and work intensity, DbA

Categories of work intensity	Category of work weight			
	Easy I	Middle II	Heavy III	Very heavy IV
Low-intense I	80	80	75	75
Middle intense II	70	70	65	65
Intense III	60	60	—	—
Very intense IV	50	50	—	—

For studying of noise influence on human condition are used materials of studying of a functional organism condition, medical surveys, morbidity.

For the characteristic of a nervous system functional condition are used chronoreflexometry, tremorometry, tests for attention, etc.

Condition of cardiovascular system characterizes arterial pressure, electrocardiogram, pulse rate, etc. For definition of acoustical analyzer function is applied voice-frequency threshold audiometry, etc. Losses of hearing are estimated for worse hearing ear according to the table 3:

Table 3 — Losses of hearing

Degree of hearing loss	On speech frequencies (arithmetic mean on frequencies 500, 1000 and 2000 lb)	On frequencies
Attributes of noise influence on ear	Less than 10 (500 Hz — 5dB; 1000 Hz — 10 dB)	Less than 40
I degree (easy decrease of hearing)	10–20	60–20
II degree (moderate decrease of hearing)	21–30	65–20
III degree (significant decrease of hearing)	31 and more	70–20

The degree of hearing loss is established on speech frequencies in view of hearing loss on frequency 4000 Hz as an attribute, professional noise influence.

The polyclinic audiometer is electro-acoustic medical device for definition of audibility thresholds of the person with air and bone conductivity.

Definition of audibility thresholds is carried out by signal injection to the probationer of simple tones of various frequency and intensity. Results registration is made on audiogramm form under patient responses by drawing points in a place of crossing of the planks connected to frequency and intensity switches.

The follow most widespread order of frequencies alternation is recommended during research: 1000, 2000, 3000, 4000, 5000, 8000, 500, 250, 125 Hz.

All received points corresponding to audibility thresholds on different frequencies for one ear are connected by lines, which represent audiogramme.

PREVENTIVE ACTIONS

The important value for working conditions improvement has precautionary sanitary inspection on development noise protective technics (equipment). Struggle against adverse influence of industrial noise is carried out in directions:

— changes of technology and noisiness reduction of the equipment;

— application of means and methods of collective protection (building-acoustic, planning, etc.);

— the warning of noise spreading in premises by sources isolation of its formation or the most noisy parts in them;

— noise absorption (furnish of premises by porous materials, etc.)

— use of individual defence means in cases when it is not possible to lower noise levels on a workplace (earplug, etc.);

— actions of organization character (work and rest mode, medical-and-planning);

— development of hygienic norms;

— preliminary and periodic medical surveys at reception on work according to order Ministry of Health of Republic Belarus № 10.

Contra-indications at receipt on work are stable hearing decrease, the expressed vegetative dysfunction, infringements of vestibular apparatus function, etc. Frequency of surveys depends on degree of excess. In surveys the therapist, the otolaryngologist, the neuropathologist take part.

Vibration concerns to the most widespread harmful production factors in the industry, an agriculture, on transport.

It can render negative influence on health and human workability, and in the certain conditions to result in development of vibrating illness.

Vibration is complex mechanical oscillatory movements of the tool, a floor, a seat, etc., transmitted to human body or separate body parts at direct contact.

Vibration is characterized by a spectrum of frequencies (Hz) and such kinematic parameters as vibrospeed (in meters per 1 sek.) or vibroaccelcration (in meters per 1 sek^2). Except for absolute values of these parameters are used also their logarithmic levels in decibels.

The basic method describing vibrating influence on worker is the frequency analysis. Measurements are made for local vibrations in octaves (compound frequencies 8; 16; 31,5; 63; 125 : 250; 500 and 1000 Hz; and for the general vibration (1, 2, 4, 8, 16, 31,5, 63 Hz) with the device help: vibrometer portable VM-1: measuring instrument of noise and vibration, etc.

Table 4 — Allowable vibrospced levels of the general technological vibration (extraction from sanitary norm)

Technological vibration	Vibrospeed (dB) in octave strips with compound frequencies (Hz)					
	2	4	8	16	31,5	63
On constant workplaces and in production premises	108	99	93	92	92	92
In laboratories, health centers, offices, premises for mental work	91	82	76	75	75	75

The analysis of the vibrating factor is given by the indication of excess of permissible level and also the conditions determining raised vibration level (table 4).

According to results of sanitary inspection the instruction about necessity of carrying out of actions on decrease of adverse influence of vibration is given.

They include:

— Organization-and-technical measures;

— Development of hygienic norms;

— Means of individual defence;

— Preliminary and periodic medical surveys according to order MH RB № 10;

— Treatment-and-prophyiactic actions (baths for hands, massage, physiotherapeutic procedures, industrial gymnastics, UVI);

— Optimization of work and rest mode.

At work with the vibrating equipment total time of contact with vibration equally 480 min. in view of two regulated breaks: the duration of first one — 20 min. (in 1–2 h after the shift beginning) and the second min. (in 2 h after a lunch break) for productive rest, special complex of industrial gymnastics, physiotherapeutic procedures, etc.

The lunch break should be not less than 40 minutes.

Duration of disposable continuous influence of vibration should not exceed 10–15 minutes. Work in conditions of vibration influence exceeding sanitary norms more than on 12 dB by an integrated estimation or in any octave strip, is not allowed (table 5).

Table 5 — Allowable total time of local vibration influence per shift depending on permissible level exceeding

Allowable levels exceeding of local vibration, dB	Allowable total time of local vibration influence per shift, min
1	384
3	240
6	120
9	60
12	30

Estimation of worker's health state, exposed to vibration influence, is earned out at inspection with the help of physiological and clinical research methods, and also at the analysis of professional and nonprofessional morbidity.

The greatest value from physiological methods have pallesthesiometry (measurement of vibrating sensitivity), algesimetry (measurement of painful sensitivity), stabilography (studying of the vestibular analyzer), dynamometry, tremorometry, electromyography, thermometry with cold test, capillaroscopy, rheography, i.e. the methods reflecting a condition of sensory system, the nervous — muscular apparatus and peripheral blood circulation.

The data of the physiological researches, which have been carried out at receipt on work, allow to reveal the persons having specific features of organism, promoting earlier development of vibrating illness (risk group).

The dust — aerodisperse system, in which dispersive medium is air, and a disperse phase — dust particles. The dust particle represents the substance in a firm condition, the size from the tenth fraction of millimeter up to fraction of a micrometer.

The industrial dust is classified by origin — organic, inorganic, mixed; by way of formation — aerosols of disintegration or condensation; by the particles sizes — visual more than 10 microns), microscopic (0,25–10 microns), ultramicroscopic (less than 0,25 microns).

The dust can have various effects on an organism: fibrogenic, toxic, irritating, cancerogenic, mutagen, teratogenic, allergenic, etc.

Dust mainly fibrogenic action in conditions of manufacture can cause chronic occupational lung diseases — pneumoconiosis, dust bronchites and other chronic diseases of a respiratory tract.

The degree and expressiveness of clinical displays of dust diseases of respiratory organs depend on dust concentration, a chemical structure, physical and chemical dust properties. A dust concentration in air of a working zone is determined in it free SiO_2 as its presence defines a degree fibrogenic property of industrial dust.

Existing methods of dust concentration definition in air are shared on **two** basic groups: 1 — the methods based on disperse phase extraction (sedimentary and aspiration, weight and accounting); 2 — methods without extraction of a disperse phase: optical, photometric, electrometric.

Table 6 — Maximum permissible concentration of aerosols mainly fibrogenic action *(extraction from sanitary norm and rules 11-19-94)*

№	The name of substance	Maximum permissible concentration, mg/m^3	Prevalence aggregative state in industry condition	Class of danger	Action on an organism
la	Silicon dioxide amorphous as a condensation aerosol at the concentration from 10 up to 60 %	2	A	3	f
b	Silicon dioxide amorphous as a condensation aerosol at the concentration more than 60%	1	A	3	f
c	Silicon dioxide amorphous as a condensation aerosol at the concentration of each of them more than 10 %	1	A	3	f
d	Silicon dioxide crystal (quartz, cristobalite) at concentration in a dust more 70 %	1	A	3	f
e	Silicon dioxide crystal at concentration in a dust from 2 up to 10 %	4	A	4	f
k	Silicon dioxide crystal at concentration in a dust from 10 up to 70 % (granite, a carbon dust), an artificial mineral fibre	2 2/0,5	A A	3 3	f f
2	Dust of a vegetative and animal origin:				
a	Gram	4	A	3	A, f
	Flour, wood, etc. with impurity SiO_2, not less than 2%	6	A	4	A, f

№	The name of substance	Maximum permissible concentration, mg/m^3	Prevalence aggregative state in industry condition	Class of danger	Action on an organism
b	Bast, cotton, linen, wool, fluff (with impurity SiO_2, more than 10 %)	2	A	4	A, f
c	With impurity SO_2, from 2 up to 10 %	4	A	4	A, f
d	Cotton flour	0,5 on fiber	A	3	A
3	Silicate and asbestos containing dust, silicates, aluminosilicate:				
a	Asbestos natural and synthetic, mixed asbes-tos dirt dust at asbestos concentration up to 10 % from 10 % — 20 % more than 20 %	 4/2 2/1 2/0,5	 A A A	 3 3 3	 f, k f, k f, k
b	Asbestos cement	6/4	A	3	f, k
c	Micas, the talc, containing up to 10 % free SiO_2	4	A	3	f
d	The glass dust and glass building materials	2	A	3	f
e	Coal dust	4	A	3	f

Symbols:
a — aerosol;
f — aerosols, mainly fibrogenic actions;
a — the substances, capable to cause allergic diseases;
K — cancerogen.
In prevention of dust diseases the important value have:
1. Measures of legislative character.
2. Struggle against dust formation and distribution.
3. Measures of individual prophylaxis.
4. Biological measures of prophylaxis.

PRACTICAL WORK

1. To solve a situational task by definition of physical factors influence and a dust in manufacture.

2. To state a hygienic estimation for working conditions and to offer measures for their optimization.

3. Results to enter in a journal.

LABORATORY WORK

Task 1: To determine noise level in a room with the help noise dosimeter.
Task 2: To give a hygienic estimation to the received results.
Task 3: To enter results of measurements in the report.

SITUATIONAL TASK

In mechanical shop of a factory equivalent noise level on constant workplaces 90 dBA, on compound frequency of 125 Hz — 122 dB, equivalent equalized level of local vibration on vibroacceleration 80 dB, vibrospeed — 118 dB, dust concentration with impurity 2 % SiO_2 — 5 mg/m^3. To give hygienic evaluation of physical factors and to offer actions for their optimization.

SAMPLE OF THE SITUATIONAL TASK DECISION

The level of physical factors and the dust concentration in mechanical shop does not correspond to hygienic requirements, the equivalent noise level (76 dB) is exceeded and vibrospeed (112 dB), the dust concentration (4 mg/m^3) is increased.

It is necessary to carry out actions on struggle against noise, vibration, high dust concentration (technological, sanitary-engineering, planning, organization). In the attitude of workers: to execute treatment-and-prophylactic actions (periodic physical examination, physiotherapeutic procedures, sanatorium treatment, etc.), for workers — to use individual means of ears, breath, vision protection, vibroprotective gauntlets.

TASK № 1

In foundry for reception of the necessary form the molten metal is filled with earth forms. Therefore in stumps, metal dressing processes dust put in air in concentration 50–100 mg/m^3, silicon dioxide concentration up to 40–50 %. Definition of dispersiveness has shown, that a dust has following sizes: up to 2 microns — 40 %, from 2 up to 5 microns — 30 %, from 5 up to 10–28 % and more than 10 microns — 2 %.

1. Give the characteristic of a dust and specify maximum permissible concentration. List probable occupational diseases at workers in the given conditions and necessary actions of treatment-and-prophylactic character.

TASK № 2

In mine there is a coal production with the help of combines. On cutter workplace the dust concentration in air is 200 mg/m^3.

Dust dispersiveness: up to 5 microns of 68 %, from 6 up to 10 microns of 22 % and more than 10 microns of 10 %. At chemical research free silicon dioxide presence in a dust in quantity of 8 % is established.

1. Give the dust characteristic, specify maximum permissible concentration and estimate a dust content of the air environment.

2. What occupational diseases can arise at workers of the given trade?

3. Name necessary actions on improvement of working conditions.

TASK № 3

At a factory of plastic in shop of polymerization at cutting Getinaks (a kind of plastic) with the help of circular saws. Getinaks concentration in breath zone of workers has made 0,5–0,8 maximum permissible concentration. Noise levels exceed allowable on 18–20 dB on all frequencies. The group of working women has addressed with the complaint on bad sleep, pains in the heart, unstable arterial pressure.

1. To define the basic harmful factor for workers in given industrial conditions.

2. To specify term of carrying out of periodic medical survey.

3. To determine structure of the medical commission both necessary laboratory and functional researches.

4. To give the list of contra-indications for work on the given manufacture.

TASK № 4

In asbestos technical manufacture on one of sites displacement in the bunker of asbestos with cotton is made. Local exhaust ventilation as an umbrella is placed above the bunker. Inspection of a workplace has shown that the concentration in air of a dust makes 40 mg/m^3. Asbestos concentration in dust structure consists of 50 %.

1. Give the characteristic of a dust. Specify maximum permissible concentration and estimate a dust concentration of the air environment.

2. What occupational diseases can arise at workers of the given trade? List the necessary preventive actions.

TASK № 5

At a machine-building factory in shop of assembly welding works are carried out. At studying working conditions is established, that in air on the worker place of the welder manganese oxides in quantity of 0,5 mg/m^3 (manganese is a part of welding electrodes and fluxes) are defined.

1. What changes can be observed in this connection at electric welders at long work?

2. What kinds of display of manganese poisons on an organism do you know?

3. What is cumulation, what kind manganese cumulation do you know?

TASK № 6

In premise of forge shop are located forge press and heating furnaces. Processable ingots are heated up, exposed to hammering, punching and pressing. Adverse factors are the raised air temperature, radiant heat up to 1800 kcal/m^2, the raised concentration in air CO and sulphurous gas. The forge shop is in one-storey building.

1. What system of ventilation should be used in the given shop?

2. Name classification of ventilation.

3. How correctly to organize medical survey of workers in given case?

4. Offer measures on improvement of working conditions.

TASK № 7

Working conditions of concreters of forming shop in a factory of ferro-concrete products were studied. Concreters carry out the following operations: preparation of forms, tilling of forms by a concrete mix, formation of products on vibratory plates for the best level concrete workers periodically used a shovel, standing on a floor.

Duration of vibration influence on a worker is 2 hours per shift. Thus on a workplace of concreters (on a floor) the following levels of vibration are registered:

Compound frequencies of octave strips, Hz	2	4	8	16	31,5	63
Vibrospeed level, dB	102	100	98	94	90	86

1. Draw the vibration spectrogram. Estimate vibration levels on work-places of concreters, using the specification.

2. What can you offer recommendations on improvement of working conditions on the given site?

TOPIC III
THE CHARACTERISTIC OF THE TRADES CONNECTED TO INFLUENCE OF INDUSTRIAL POISONS. PROPHYLAXIS OF POISONINGS

Total time — 4 hours

PRACTICAL SKILLS:

To be able to estimate working conditions in production and to appoint a complex of the preventive actions directed on improvement of working conditions and health preservation.

To be able to make out the certificate (act) of occupational disease or poisoning investigation.

THE BASIC EDUCATIONAL QUESTIONS

1. Chemical harmful substances in the industry and in agriculture, their action on an organism (total, selective, local, specific, combined). Entry and excretion ways of substances.

2. Acute and chronic industrial poisonings. Toxicology of the basic groups of industrial poisons (carcinogens, allergens, mutagens, etc.).

3. The factors determining manner and a toxicity degree of chemical substances (individual sensitivity, sex, age, chemical structure and physical properties of poisons, concentration and duration of poison action, conditions of influence). Threshold principles.

4. Key parameters describing acute toxicity at different reception substances paths in an organism, ability to cumulate and danger of long-term exposure.

5. Experimental assessment of new chemical substances with the purpose of their hygienic standardization in air of a working zone.

6. Hygiene of work in agriculture.

7. Prophylaxis of acute and chronic poisonings in industry.

AUXILIARY MATERIALS

Poisons are the substances which, getting in an organism in little amount, initiate in it chemical or physical-and-chemical interaction with tissues and under certain conditions cause health disorders.

Professional or industrial poisons are chemical substances which as raw material, intermediate or ready products meet in manufacture conditions and at organism penetration cause disorders of it normal vital activity.

Industrial poisons are various on character of action and can be referred to dangerous (provoking acute health disorders and death) or harmful rendering negative influence on workability and causing professional illnesses and other negative consequences.

To chemical harmful and dangerous production factors concern gases, vapour, liquids and the aerosols rendering total toxic, irritating, sensibilizing, cancerogenic, mutagen action, influence on reproductive function, etc.

In an organism industrial poisons can act through respiratory organs, gastrointestinal tract and the intact skin. However the majority of substances gets in an organism through lungs. In this connection the constant control of the concentration of these substances in air of a working zone is necessary. The substances penetrating through the skin, demand research of a pollution degree of integuments by them and surrounding subjects.

Action of poisons can be the general (resorptive) and local. The general action develops in result of poison absorption in blood. At that the relative selectivity is quite often observed.

At local action tissues damaged on a place of their contact with poison (irritation, inflammation, a burn) prevails.

Industrial poisons can cause specific acute, subacute and chronic poisonings, can reduce immunobiological organism resistibility, promote development of illnesses (catarrh of upper airways, a tuberculosis, kidney diseases, diseases of cardiovascular system, etc.), to cause allergic diseases (bronchial asthma, eczema, etc.), to render embryotoxic (teratogen), cancerogenic actions, a number of the long-term effects.

Isolated action of poisons on manufacture occurs seldom, i.e. the combined action of poisons takes place.

Distinguish some kinds of the combined action of poisons:

1. Homogeneous action — mix components act on the same systems in the organism. In these cases it is said about simple additivity (addition) — or about simple summation: the total mix effect is equal to the sum of effects of working components.

2. Independent action — mix components act on different systems, toxic effects are not connected with each other.

3. Synergism, or potentiation, — the effect of the combined action, it is more, than the sum of actions of separate substances.

4. Antagonism — the combined action with the less effect, than the sum of actions of separate substances of a mix.

What «destiny» of the poisons which have got in an organism? In blood and tissues there are physical and chemical interaction processes of poisons to cellular membranes, albuminous structures and other cell's components and the intertissues medium. A biological orientation of these processes is poisons neutralization by various ways.

The first and main way of neutralization is change of poisons chemical structure, mainly, in a liver, adrenal glands by their oxidation, restoration, disintegration, methylation, formations of complex pair connection, etc.

The important role in poison neutralization is connected with their deposition (cumulation) and excretion. Deposition (postponement in those or other organs) is temporary way of poison quantity reduction circulating in blood.

Poisons excertion from an organism occurs by ifferent ways: through respiratory way, digestion, kidney, skin, glands.

Industrial poisonings proceed with acute, subacute and chronic forms.

Acute poisonings are more often are group and arise in case of an emergency. These poisonings are characterized:

1. Short duration of poison action — it is no more than during one shift.

2. Poison entry to organism in relatively large amount.

3. Strongly pronounced clinical presentations at once or in the short period.

Chronic poisonings arise gradually, at long action of the poisons penetrating into an organism in quite little amount. They develop owing to poison accumulation in an organism (material cumulation) or changes caused by it (functional cumulation).

Subacute forms of poisonings are similar with acute one on occurrence conditions and clinical presentations, but develop more slowly and have more prolonged current.

The toxic effect at action of different dozes and poisons concentration can be shown in the form of organism destruction or functional and pathologic changes. In the first case toxicity can be expressed as lethal; in the second — effective, threshold and noneffective dozes and concentration.

Lethal dozes (DL) and concentration (CL) can cause isolated instances of destruction (min) or destruction of all organisms (absolutely lethal). But these sizes are fluctuating wide-ranging, therefore at toxicity expression it are denoted middle-lethal dozes and concentration (DL_{50} and CL_{50}) which cause destruction of 50 % of animals at single [acute] dosing in a stomach (DL_{50}, mg/kg), at reception of substance through the intact skin (DL_{50}, mg/kg), at 2–4 hour inhalation (CL_{50}, mg/m^3).

Toxicity of poisons is more, than less than size DL_{50} and CL_{50},
i. e. toxicity = $\frac{1}{DL_{50}}$ or $\frac{1}{CL_{50}}$

Danger of poison depends not only on toxicity of substance, but also, first of all, from it volatility.

Danger of chemical substances is frequently estimated on size FOIP — factor of opportunity of an inhalation poisoning: which is equal to relation $C_{20°}/CL_{50}$ — 120 min., where $C_{20°}$ — maximal achievable substance concentration at 20 °C. CL_{50} — 120 min. is middle-lethal concentration for animals at two-hour effect (120 minutes).

Studying early functional and pathological changes is important depending on poison quantity which has acted in an organism. With this purpose are defined so-called acting (effective, toxic; dozes and concentration which cause attributes of an organism intoxication, and also threshold and non-effective doses. Threshold dozes and concentration refer to manifestation of poison action as it were on the verge of physiological and pathological changes, below them settle down non-effective doses. Definition of thresholds of acute and chronic action allows to establish zones of acute and chronic action and on the basis of all characteristics to approach to a substantiation of maximal permissible concentration of poison in air of a working zone.

Maximal permissible concentration (maximal concentration limit) of harmful substances in air of working zone — concentration, which at daily (except for the days off) work during 8 h. or at other duration, but no more than 41 h. in a week, during all working experience cannot cause diseases or deviations in health state, detectable by contemporary researches methods during work process or in long-term of life of the present and the subsequent generations.

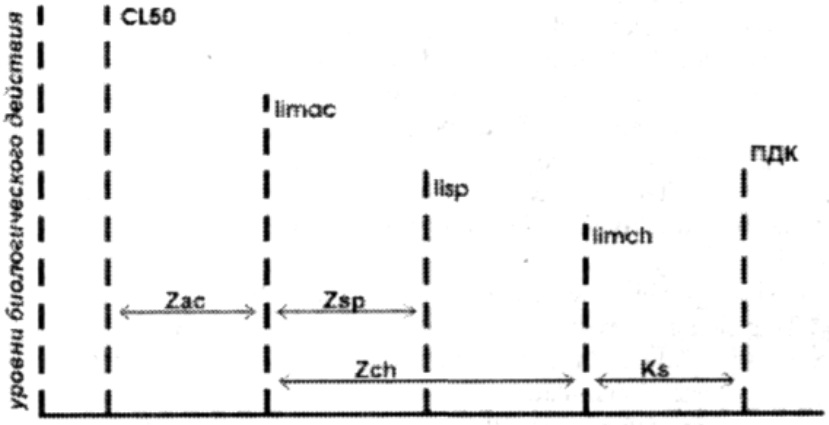
The relation refers to as a **zone of acute action:** $\frac{CL50}{\lim ac}$,
where: lim *ac* — threshold of acute action.

It shows concentration excursion rendering action on an organism at single dosing from initial up to extreme forms of effect.

The relation refers to as a **zone of chronic action:** $\frac{\lim ac}{\lim ch}$,
where: lim *ch* — threshold of chronic action.

It shows how many is great break between dozes and the concentration causing the initial intoxication phenomena at single dosing and at long reception in an organism.

PARAMETERS TOXICOMETRY — TOXICITY AND DANGER



CL_{50} — middle-lethal concentration;
lim ac — threshold of acute action;
lim sp — threshold of specific action;
lim ch — threshold of chronic action;
ПДК — maximal-permissible concentration;
Zac, Zch, Zsp — zones of acute, chronic and specific action;
Ks — cumulation coefficient.

The less zone of acute action — substance is more dangerous.

The more widely the zone of chronic action — substance is more dangerous, since the concentration rendering chronic action, much less causing acute poisoning.

The chronic poisoning at action of such substance develops is latent, since there is gradual substance accumulation or toxic effect (material or functional cumulation).

Ks (cumulation coefficient) = Σ DL_{50}/DL_{50}, where Σ DL_{50} — the total doze resulted in death of 50 % experimental animals at multiple intragastric introduction of dozes, making 0,1 from DL_{50}.

The toxic effect depends not only on a doze and concentration of substance: time (duration) and periodicity of poisons effect matter also: W = ct.

These are so-called chronoconcentration poisons (phosgene, hydrogen sulphide, sulphur dioxide, aromatic hydrocarbons).

At a substantiation of maximal permissible concentration of industrial poisons issue:

a) physical and chemical properties of substance;

b) results of experimental researches;

c) data of hygienic supervision on manufacture, materials about a health state and worker's morbidity.

Experimental researches can be executed in the full or reduced volume.

Studying of a picture acute, subacute and a chronic poisoning in experiences on animals is carried out both on external manifestations of intoxication, and on physiological, biochemical and histomorphologic attributes with the purpose of revealing the general and specific manifestations of intoxication. Are es-

tablished the upper and lower parameters of toxicity, i. e. lethal dozes and concentration, a threshold of acute and chronic action.

These quantitative indicators of substance toxicity are necessary for definition of acute and chronic toxic action zones, potential inhalation poisoning factor (PIPF).

Maximal permissible concentration is established in 2–3 times lower then lim_{ch}. This factor of reduction refers to as **cumulation coefficient** (index of safety, factor of durability). Its size is more, than narrower acute toxic action zone, the expressed cumulative properties, the zone of chronic toxic action is wider. Are taken into account PTPF, opportunity of skin resorptive action: they are more significant, the it is more cumulation coefficient. At revealing specific action — gonadotropic, blastogenic, sensitizing — are accepted the greatest sizes of cumulation coefficient (10 and more).

The estimation of toxicity and danger degree of substance at single [acute] dosing is given on the basis of classification of substances danger (table 1).

It is accepted to distinguish 4 classes of substances:

1. Extremely dangerous.
2. High-dangerous.
3. Middle-dangerous.
4. Low-dangerous.

Table 1 — Parameters of danger class

Parameter	Class of danger			
	1	2	3	4
DL50ж, mg/kg	< 15	15–150	151–5000	> 5000
DL50к, mg/kg	< 100	100–500	501–2500	> 2500
CL50, mg/m^3	< 500	500–5000	5001–50000	> 50000
PIPF	> 300	300-30	29–3	< 3
Z_{ac}	< 6	6–18	18–54	> 54
CC	< 1	1–2,2	2,3–5	> 5
Z_{ch}	> 10	10–5	4,9–2,5	> 2,5
Maximal permisible concentr. Mg/m^3	< 0,1	0,1–1	1,1–10	> 10

To each class there corresponds the certain level of maximal permissible concentration.

Maximal permissible concentration of harmful substances in air of a working zone (extraction from State Standard 12.1.005.-88 and Sanitary Rules and Norms are applied as the table).

At simultaneous presence in air of working zone several harmful substances of the unit-directional effect the sum of relations of actual concentration of each of them (C_1, C_2 … … ..... C_3) in air to their maximal permissible concentration (MPC_1, MPC_2 … … . MPC_3) which are established for isolated presence, should not exceed 1:

$$\frac{C_1}{MPC_1} + \frac{C_2}{MPC_2} + ... \frac{C_n}{MPC_n} < 1$$

THE SAN1TARY-AND-HYGIENTC CONTROL FOR APPLICATION OF PESTICIDES, MINERAL FERTILIZERS IN THE AGRICULTURE

Pesticides are the chemical substances used for protection of plants from illnesses, wreckers and weeds.

Pesticides are on chemical structure divided into the following groups:

1. Inorganic compositions (arsenic, fluorine, barium, sulfur, copper, chlorates, borates).

2. Pesticides of a vegetative, bacterial and mushroom origin (pyretrins, anabasines, nicotine, bacterial preparations and antibiotics).

3. Organic compositions — the most extensive group of pesticides of high biological activity.

a) chlororganic compounds;

b) phosphoorganic compounds;

c) derivatives of aminoformic, thio- and dithiocarbamic acid;

d) mercury organic compounds;

e) chlorphenoxyacetic acid derivatives;

f) nitroderivatives of phenol;

g) phthalimide and others.

On industrial purpose pesticides are subdivided into groups:

1. Means of control pest of plants (insecticide, zoocide).

2. Means for struggle against mushroom and bacterial illnesses of plants (pesticides used for seed sterilization).

3. Means for struggle against weed and undesirable vegetation (herbicides, defoliant).

4. Regulators of plants growth.

Hygienic classification of pesticides (table 2):

I. On toxicity at unitary receipt in an organism through a digestive path pesticides share on:

1. Strongly working poisonous substances — DL_{50} up to 50 mg/kg.

2. Highly toxic — DL_{50} — 50–200 mg/kg.

3. Middle toxic — DL_{50} — 200–1000 mg/kg.

4. Little toxic — DL_{50} more than 1000 mg/kg.

II. On cumulative properties distinguish the pesticides causing:

1. Overcumulation — coefficient cumulation less than 1.

2. High-grade cumulation — CC — 1–3.

3. Moderate cumulation — CC — 3–5.

4. Weak cumulation — CC — more than 5.

III. On stability:

1. Very stable — decomposition time on nontoxical components — over 2 years.

2. Stable — 0,5–1 year.

3. Moderately stable — 1–6 months.

4. Not stable — 1 month.

Phosphoorganic pesticides (metaphos, trichlorfon, thiophos) at influence of high temperature are m partly or completely destroyed.

Chlororganic pesticides are stable to influence of high temperature, practically insoluble in water.

Derivative of aminoformic acids (sevin, pyram) are stable to high temperature, have citogenetic activity, gonadotoxic properties, high-grade cumulative action, in the sour medium destruction is considerably accelerated.

Table 2 — The characteristic of some pesticides»

The name	Degree			Notice
	acute toxicity	cumulation	stability	
Hexachloran	3	2	1	Embryotoxic, mutagenic action
Keltan	3	2	2	
Thiophos	1	3	3	
Carbaphos	3	2	3	Irritates skin and mucous membranes
Metaphos	1	4	3	
Trichlorfon	3	3	3	
Sevin	3	4	2	Gonadotoxic action
Cirum	3	3	3	Gonadoembryotoxie

Means of an individual defence against pesticides are obligatory for all workers with pesticides; they have complete set of clothes (overalls, protective goggles, footwear, respirator or gas mask, gloves or gauntlet, etc. which is kept in separate lockers of cloakroom in warehouse or in specially allocated rooms.

After work completing individual protective means are taken off in the certain order (gloves (not removing from hands) wash in a neutralizing solution (3–5 % solution soda ash, wash out in water, then (not removing gloves) take off glasses, a respirator, boots and an overalls; again wash out gloves in a neutralizing solution and water and take off them.

TOTAL PROTECTING MEASURES AGAINST PROFESSIONAL POISONINGS

1. Poison elimination from technological process.

2. Perfection of technology and the equipment (mechanization, automation, etc.).

3. Hygienic and sanitary-engineering actions:

— Hygienic standardization of raw material;

— The control over air condition in a working zone;

— Use of means of individual defense (MID);

— Use of corresponding kinds of a lay-out and rooms furnish and arrangement of the equipment;

— Sanitary training of workers;

— Sanitary-educational work.

4. Legislative sanitary and treatment-and-prophylactic actions:

— Reduction of working hours, increase in holiday duration, earlier terms retire on a pension;

— Ministry of Health RB order «About obligatory preliminary at reception on work and the subsequent periodic medical surveys of workers»;

— Additional and special nutrition.

TASK № 1

The type-setter of a printing office (record of service — 12 years) has addressed to the shop doctor with complaints on periodic colicky pain in a stomach. Precise connection of pain occurrence with food reception worker does not mark.

The worker is hospitalized in medical department of office. As a result of inspection the following deviations in a health state are revealed: asthenovegetative syndrome; in blood — anemia, reticulocytosis, basophilic granularity in erythrocytes. At interrogation it was found out, that ventilation in shop frequently fails. Washstands in shop are absent. This worker smokes.

1. *What occupational disease at the worker? What are possible his symptoms?*

2. *List the actions of sanitary-and-hygienic and treatment-and-prophylactic character directed on preventive maintenance of the given occupational disease.*

3. *What doctors should participate in carrying out of periodic medical examinations of the workers of this trades?*

4. *To issue the act of occupational disease investigation.*

TASK № 2

The worker of manufacture of special grades of ceramic and refractory bricks has addressed to the shop doctor with complaints on increasing weakness, weight loss. Taking into account contact to beryllium hydroxide (finely disperse powder) the worker was hospitalized for examination. At studying of working conditions it is established, that concentration of beryllium hydroxide exceeds allowable levels in air on workplaces in 2–2,2 times. Industrial operations are carried out in not hermetically sealed bin, process is mechanized only on 20 %, remote control is absent. Technological communications are covered with a dust of beryllium hydroxide.

Workers work in respirators, gloves, dressing gownes. Ventilation of a working room is general.

1. *Give the characteristic of working condition.*

2. *What symptoms of disease at the worker are possible?*

3. *Specify what sanitary-and-hygienic and medical preventive actions it is necessary to carry out for working condition improvement.*

4. *To issue the certificate of occupational disease investigation.*

TASK № 3

Machine operative of shops of nitric acid production (record of service — 4 years) for last 2 years constantly address to the stomatologist with complain on progressive teeth destruction. She marks also often apper respiratory ways catarrh. Concentration of nitrogen oxides in air of an industrial premise make 17–20 mg/m^3. Temperature of air — 26–28°. Machine operative 60 % working

hours carries out in shop, serving communications. Thus she carries out the visual control over indications of devices, adjustment of gates, sampling manually.

Emergency emissions of nitrogen oxides are possible, in this case machine operative use respirators.

1. *What occupational disease is possible at machine operative in this shop? To issue the act of occupational disease investigation. What symptoms of disease (the acute, chronic form, semiology and others) can be yet? List necessary improving actions which should be applied out in the given shop.*

TASK № 4

In engineering plant in assembly shop welding works are carried out. At studying working conditions it is established, that in air on workplace of die welder manganese oxides in quantity of 0,5 mg/m^3 (manganese is part of welding electrodes and fluxes) are defined.

1. *What changes can be observed in this connection at electric welders at continuous duty?*

2. *What do you know about symptoms of poisons action on an organism, to what from them you will relate manganese?*

3. *What is it cumulation, what cumulation kind manganes has?*

TASK № 5

The on-the-job safely engineer of shoe factory has addressed in the Center of hygiene and epidemiology with the request to define benzol concentration in air used as solvent on a gluing site.

As a result of research it is established, that the benzol content in air on workplaces shoe workers makes 0,015 mg /1.

1. *What methods of research cart be used for benzol definition in air under the given condition?*

2. *Draw the conclusion about conformity air pollution by benzol to sanitary norms.*

3. *Specify the actions of sanitary-and-hygienic and treatment-and-prophylactic character necessary for improvement of working condition.*

TASK № 6

The shop doctor of accumulator factory has draw attention on skin pallor at some workers contacting with the fused lead. At blood analysis at them has been marked reduction of hemoglobin, are revealed reticulocytosis, basophilic granularity in erythrocytes.

1. *What hygienic and medical researches are necessary additionally for confirmation or exclusion an opportunity of a poisoning by lead vapour?*

2. *List preventive actions which the doctor should carry out in this case.*

3. *Specify ways of lead reception to an organism, a way of its deducing and also deposition place of lead in an organism.*

4. *To issue the act of occupational disease investigation.*

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