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LABOUR SAFETY

Lecture Course

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The contents of the textbook "Labour Safety: Lecture Course" corresponds with the basic educational plan and program provided by Ministry of the Health Care of the Republic of Belarus.

The lecture course is prepared for students of medical faculties of high medical educational establishments.

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PREFACE

The purpose of labour safety at higher medical educational establishments is to give the future doctor ability to estimate dangerous and harmful production factors, to use individual protection against them at a manufacture and at performance of technological processes, to develop and carry out actions for labour safety.

The essence of labour safety and its problems, legislative and standard legal acts on labour safety, the control over their observance, the rights and duties of workers and employers on labour safety, accidents at manufacture, their investigation and account, bases of rendering of the first medical aid are stated in the lecture course.

The lecture course pays the big attention to safety measures bases where the data on preventions of dangerous influence of the production factors leading to traumas, acute poisonings, sudden sharp deterioration of health are described. Work safety issues at operation of medical apparatus, at work with biological objects are stated. The basic sanitary demands to objects of economic activities, the sanitary characteristic of harmful production factors are also described. Concepts of fire safety at objects, actions for prevention and liquidation of fires, management of fire safety and organization of fire protection of objects are surveyed.

The lecture course is intended for students of medical faculties of high medical educational establishments, students of the other specialities studying labour safety, and also can be useful to doctors.

LECTURE 1. LEGAL AND ORGANIZATIONAL ASPECTS OF LABOUR SAFETY

Study questions

1. Introduction.

2. The basic concepts of labour safety.

3. The legislative and standard legal certificates on labour safety and control over their observance.

4. The rights and duties of workers and employers on labour safety. Responsibility for delict of work legislation.

5. Management of labour safety. Labour safety of women and youth.

6. Training of workers for occupational safety. Certification of workplaces.

7. Accidents at factories, their investigation and registration. Bases of rendering of first medical aid.

8. Summary.

1. Work is a basis of formation and social development of a person, creation of stocks of materials and capital equipment. Correctly organized labour process renders beneficial effect on health, physical, intellectual and moral perfection of people. At the same time work of workers is potentially hazardous in some productions and requires protection.

The policy of the state in the field of labour safety is based on maintenance **of priority of life and health** of workers in relation to results of industrial activity. The basic summands of this policy include:

- the government activity in the field of labour safety,
- preparation and acceptance of laws and other standard legal certificates on maintenance of safety and improvement of working conditions,
- establishment of uniform standard demands on labour safety,
- participation of the state in labour safety financing, economical incentive of activity on creation and introduction of healthy and safe working conditions,
- working out and introduction of safe technics and technologies, collective and individual protections of workers,
- application of sanctions of economic, administrative and criminal character in events of rules violation on labour safety,
- establishment of indemnifications and privileges for works with harmful or hazardous working conditions,
- preparation of experts in the field of labour safety,
- creation of system of information and monitoring of labour safety,

- realization of actions for propagation of the best practices in the field of labour safety,
- international cooperation at the decision of safety problems and labour safety.

Labour safety is especially important at medical institutions (medical university), public health organizations (hospital, out-patient-polyclinic, pharmaceutical and other organizations), pharmaceutical and other enterprises for the future medical workers with higher education.

Educational institution – is an object of economic activities which realizes educational process and, accordingly, renders educational services.

Public health organization – is an object which realizes medical or pharmaceutical activity and renders medical services.

Enterprise – is an object bound to production, performance of works and rendering of services which are realized with use of the processes, equipment and technologies which are sources of influence inhabitancy and human health.

Because labour safety is referred on maintenance of safety of life, health and working capacity of workers in the course of industrial activity and promotes reduction and prevention of industrial injury, general and occupational diseases of workers, it has great value for preparation and further professional work of various profile doctors and other experts of public health organizations.

2. Working conditions affect on health and working capacity of workers in the course of labour activity. **Working conditions** – a set of factors of working environment.

Classification of working conditions:

- ✓ optimum,
- ✓ admissible,
- ✓ harmful
- ✓ dangerous.

Dangerous and harmful production factors make adverse impact on human health.

Dangerous production factor (causing injuries) - a production factor, which influence on worker in certain conditions results in a trauma, acute poisoning and (or) sudden acute health deteriorations or death of workers.

Harmful production factor (causing disease) - a production factor, which influence on worker in certain conditions can cause a disease, depression of working capacity and (or) negative influence on posterity health.

Dangerous and harmful production factors on action nature are subdivided into ***physical, chemical, biological and psychophysiological.***

Physical dangerous and harmful production factors: high smokiness, dustiness and gassy area of working place, moving cars, mechanisms, parts of industri-

al equipment, products, billets and materials, breaking designs, falling rocks, discomfortable microclimate with high or low air temperature, humidity and mobility of air of a working zone, high level of noise, vibration, ultrasound and infrasound, high or low barometric pressure, high voltage in electric network, static electricity, voltage of electric or magnetic field, insufficient natural or artificial light exposure, high brightness of light, pulsation of luminous flux or low contrast, high level of electromagnetic, ionizing, ultra-violet or laser radiation, acute ridges, spews and roughnesses on surface of instruments, billets and equipment, workplace locating at height, weightlessness.

Chemical dangerous and harmful production factors: chemical organic (aldehydes, alcohol, ketones, etc.), elementorganic (organophosphorous, organochlorine compounds, etc.) and inorganic (lead, mercury, etc.) compounds in the form of solid substances, liquids, gases, steams, aerosols and their mixtures. Chemical dangerous and harmful production factors on the nature actions on human body are divided into the following subgroups: general toxic, irritant, sensitizing (causing allergic disease), carcinogenic (causing the development of tumors), mutagenic (acting on germ cells). This group includes many vapors and gases: a pair of benzene and toluene, carbon monoxide, sulfur dioxide, nitrogen oxides, aerosols, lead and other toxic dust formed, for example, when processing machining of beryllium, lead bronze and brass and some plastics with harmful ingredients. This group include aggressive liquids (acids, alkalis), which may cause chemical burns of the skin in contact with them.

Biological dangerous and harmful production factors: microorganisms (bacteria, viruses, ricketsia, spirochetes, funguses, actinomycetes, elementary), macroorganisms (plants, animals) and also products of their vital activity, whose impact on workers is injury or disease.

Psychophysiological dangerous and harmful production factors on character of influence are subdivided into physical (static and dynamic) and psychological overloads (emotional and intellectual load, efforts of analyzer functions, monotony). They are characterised by power of external mechanical work, one-trip magnitude of load lifted manually, working pose, body slope, moving in space, rate of work, number of movements at an hour, intensity of attention, analyzer functions, monotony, aesthetic and physiological discomfort, interchangeability, etc.

It is necessary to mean, that the same dangerous or harmful production factor on its action nature can simultaneously be of various groups of factors, and depending on the quantity and duration of influence the harmful production factor can become dangerous.

Between harmful and dangerous production factors some relationship is observed. In many cases, the presence of harmful factors contributes to the manifestation of traumatic factors. For example, excessive humidity in the production room

and the presence of conductive dust (hazards) increase the risk of electric shock defeat (dangerous factor).

Occupational safety must be provided at objects of economic activities. **Occupational safety** - a state of working conditions at which influence of dangerous and harmful production factors on workers is excluded or does not exceed maximum permissible value. Labour safety develops matters of safe labour activity.

Labour safety – is a science about safety, conservation of health and working capacity of human in the course of work.

Labour safety **purpose** – is working out of legal, social and economic, organizational, sanitary-engineering, psychophysiological, planning, technological, sanitary-and-hygienic, treatment-and-prophylactic, rehabilitational and other actions and means referred on maintenance of working capacity, safety of life, health of workers, and also reduction and prevention of their industrial injury, general and occupational morbidity.

Labour safety **tasks** – are studying of industrial hazards and risks, revealing of their sources, quantity and quality assesment, and also working out of principles, methods and means for achievement of the specified purpose.

- A hazard is something that can cause harm if not controlled. The outcome is the harm that results from an uncontrolled hazard.
- A risk is a combination of the probability that a particular outcome will occur and the severity of the harm involved.

Hazard, risk and outcome are used in other fields to describe e.g. environmental damage, or damage to equipment. However, in the context of labour safety, harm generally describes the direct or indirect degradation, temporary or permanent, of the physical, mental, or social well-being of workers. For example, repetitively carrying out manual handling of heavy objects is a hazard. The outcome could be a musculoskeletal disorder or an acute back or joint injury. The risk can be expressed numerically (e.g. a 0.5 or 50/50 chance of the outcome occurring during a year), in relative terms (e.g. high/medium/low), or with a multi-dimensional classification scheme (e.g. situation-specific risks).

Methodological basis of labour safety – is the scientific analysis of technological process, equipment, working conditions, used and received products from the point of view of possibility of occurrence of dangerous and harmful production factors in process of operation. Potentially dangerous sites of production, possible emergency conditions are revealed on the basis of such analysis and actions for their prevention and liquidation are developed.

In labour safety and health **physical, chemical and microbiological** methods are applied to study of production factors. In need of reception of fast result **quick tests** are applied. For the analysis of the reasons of accidents, occupational mor-

bidity **statistical, monographic, economic** and other methods are used. Management of labour safety is carried out with **prognostic and retrospective** methods.

Labour safety is a cross-disciplinary area concerned with protecting the safety, health and welfare of people engaged in work or employment. The goal of all labour safety programs is to foster a safe work environment. As a secondary effect, it may also protect co-workers, family members, employers, customers, suppliers, nearby communities, and other members of the public who are impacted by the workplace environment. It may involve interactions among many subject areas, including occupational medicine, occupational (or industrial) hygiene, public health, safety engineering, chemistry, biochemistry, mathematics, medical and biological physics, medical biology, microbiology, normal physiology and also propedeutics and therapy of occupational diseases and poisonings.

Studying of problems of labour safety is made in *technical* and *medical* directions.

The **technical direction** of research of scientific problems of labour safety includes investigation of accident prevention and industrial sanitary science questions.

Accident prevention – is the system of organizational and technical actions, technical ways and means providing protection of the personnel from dangerous production factors, resulting to an injury and death of workers.

Industrial sanitary science – is the system of organizational, sanitary-and-hygienic actions, technical means and methods for preventing or reducing of influence workers of harmful production factors to not high than maximum permissible value. Industrial sanitary science is an area of practical application of sanitary norms and rules scientifically proved by occupational hygiene.

Occupational hygiene - is a science about influence organism of workers of production factors and prevention of their adverse influence health, preventive maintenance of occupational diseases and poisonings.

The technical direction of studying of problems of labour safety is carried out by information gathering and analysis of the accidents reasons, events of injure, diseases and poisonings at the separate enterprise, on the whole at the branch and the country taking into account state of health of a worker, his age and seniority, kind of work, season of year, district climate etc. Obtained data are the basis of legislative acts on occupational safety and are used for working out of collective and individual measures of protection of health of workers from dangerous and harmful factors in the course of labour activity.

The **medical direction** of studying of problems of labour safety is made by information gathering and analysis of state of health in separate collectives, at the industries and on the whole at the country taking into account age, seniority, season of year, climatic parameters and contact to production factors. Obtained data are

the basis of the sanitary legislation and allow developing the corresponding treatment-and-prophylactic actions including individual protection.

Medical-sanitary parts have great value in realization of the medical direction. **Factory's sectorial doctor** – is a basic figure for rendering to workers of medical aid. He organizes and makes medical inspections, carries out dispensary observation of state of patients' health, participates in carrying out of antiepidemic and sanitary-and-hygienic work, actively participates in valeological training and education.

In case of revealing of occupational disease during medical inspection the sanitary-and-hygienic characteristic of working conditions of the worker is made, the characteristic of the lead and concomitant harmful factors of working environment is given. The plan of sanitary-and-hygienic and treatment-and-prophylactic actions on the basis of results of survey is developed. It includes improvement of working conditions of workers, dispensary observation and treatment organization, determination of possibility of the further work of the worker with the professional pathology.

For preventive maintenance of occupational diseases the next actions are developed:

✓ **legislative** (articles in Constitution, Labour Code, maximum permissible concentrations and levels, approximate safety level of influence, etc.),

✓ **technological** (perfection of equipment, technological process, introduction of nonwaste technologies, etc.),

✓ **sanitary-engineering** (ventilation, heating, illumination, establishment of screens, etc.),

✓ **planning** (rational lay-out of premises, sanitary-household premises, etc.),

✓ **organizational** (rational work and rest regime, interchangeability, etc.),

✓ **treatment-and-prophylactic** (preliminary and periodic medical inspections, medical and preventive nutrition, sanatorium treatment, application of individual protection, etc.).

3. The legislation in the field of labour safety is an important element of legal maintenance of social and economic relations in a society and creations of healthy and safe working conditions for working members of a society.

Labour law (or "labor", or "employment" law) is the body of laws, administrative rulings, and precedents which address the legal rights of, and restrictions on, working people and their organizations. As such, it mediates many aspects of the relationship between trade unions, employers and employees. In most countries there are two broad categories of labour law. First, collective labour law relates to the tripartite relationship between employee, employer and union. Second, individual labour law concerns employees' rights at work and through the contract for work. The labour movement has been instrumental in the enacting of

laws protecting labour rights in the 19th and 20th centuries. Labour rights have been integral to the social and economic development since the industrial revolution.

Labour law arose due to the demands for workers for better conditions, the right to organize, and the simultaneous demands of employers to restrict the powers of workers' many organizations and to keep labour costs low. Employers' costs can increase due to workers organizing to win higher wages, or by laws imposing costly requirements, such as health and safety or equal opportunities conditions. Workers' organizations, such as trade unions, can also transcend purely industrial disputes, and gain political power. The state of labour law at any one time is therefore both the product of, and a component of, struggles between different interests in society.

System of the acts controlling questions of labour safety in the Republic of Belarus:

- ✓ Constitution of the Republic of Belarus,
- ✓ Labour code of the Republic of Belarus,
- ✓ Laws of the Republic of Belarus «About bases of the state social insurance», «About pension provision», «About sanitary-epidemic well-being of the population», «About assessment of conformity to demands of technical statutory acts in the field of technical control and standardization», «About fire safety», «About industrial safety of hazardous industrial objects», «About radiation safety of the population», «About health protection», «About the enterprises», etc.

Activity on labour safety, besides laws, is controlled **by directive documents** - decrees, edicts and orders of the President of our country, and also decisions and orders of the Government of the Republic of Belarus.

Labour code of the Republic of Belarus is the basic legislation act controlling the relations in the field of labour safety between workers and employers. He describes the basic principles of organization of labour safety, defines duties of employers and workers on maintenance of healthy and safe working conditions, controls other questions bound to establishment and protection of the labour rights of workers.

The basic directions of accident prevention, occupational hygiene, industrial sanitary science and fire preventive maintenance also are regulated by interstate and state standard legal certificates, technical standard legal documents of the state supervision and control organs, branch-wise standard legal certificates of the ministries and other republican state bodies, incorporations and establishments, local standard legal certificates. Rules, norms, standards and other statutory acts on labour safety operating in the Republic of Belarus are shown in the State register.

Statutory acts on labour safety are:

1. Rules on labour safety which are subdivided in uniform for all branches and branch, are confirmed with participation of trade unions and are obligatory for employers;

2. Occupational safety standards system standards (SSSO) developed for the purpose of labour safety perfection. At standardization the basis and prospect of optimization of industrial equipment and technological processes, decisions of the further problems on improvement of working conditions are given;

3. Building norms RB (BNB), standards RB (SB);

4. Documents on hygiene of work and industrial sanitary (sanitary rules and norms - SanNaR and hygienic specifications - HS);

5. Rules for Construction and Safe Operation, safety rules (nuclear, radiating, laser, fire, electrosecurity, etc.);

6. The local normative acts accepted according to the legislation for the purpose of their application for the certain employer (regulations, collective agreements, instructions on labour safety, etc.).

Instructions on labour safety include the demands on safe performance of works.

Collective agreement is the local statutory act controlling labour and social and economic relations between the employer and workers. It regulates the terms and conditions of employees in their workplace, their duties and the duties of the employer. It is usually the result of a process of collective bargaining between an employer (or a number of employers) and a trade union representing workers.It is made for one - three years and includes positions about creation of healthy and safe working conditions, health improvement, safeguards of medical insurance of members of labour collective and their families, environmental control, adjustment of the labour schedule and discipline of work, responsibility of the employer for a harm caused to health of workers.

The basic feature of labour law in almost every country is that the rights and obligations of the worker and the employer between one another are mediated through the contract of employment between the two. **Labour contract** is an agreement between the worker and the employer. According to it the worker undertakes to perform work on one or several trades, specialities or posts of corresponding qualification taking into account the list of members of staff and to observe the labour schedule.

General supervision and control over legislation observance on labour safety is carried out by the General public prosecutor and the Offices of Public Prosecutor subordinated to him and also local authorities executive powers. The government and the control over labour safety are carried out by Council of Ministers of the Republic of Belarus through the Ministry of Labour and Social Protection.

4. The right for healthy and safe working conditions is one of the most important constitutional laws of citizens of the Republic of Belarus. Along with the rights for healthy and safe working conditions each worker has the right to a workplace corresponding to demands of labour safety, training to safe work methods, maintenance with necessary collective and individual protection and sanitary-household premises, receipt of the information on conditions and labor safety on a workplace at the employer and also about protection from influence of harmful and hazardous production factors, carrying out of checks on labour safety on a workplace, refusal of performance of the work in case of occurrence of immediate hazard to his life and health before elimination of this hazard, and also in the absence of the individual protection directly providing occupational safety.

According to laws of Labour code **employer has duties** on creation of healthy and safe working conditions for workers, introduction of the newest agents and technologies on maintenance of sanitary-and-hygienic norms and demands of standards of labour safety. Also the employer is obliged to provide all workplaces with the necessary equipment, corresponding demands on labour safety, to improve a working condition and life of workers, to observe the legislation on work, to make instructing of workers on labour and fire safety, to provide workers with overalls, individual protection, to give privileges and indemnifications for work in an adverse environment, and also to carry out the constant control over observance by workers of all demands of labour safety instructions, to make investigation and registration of accidents at production.

According to laws of Labour code **workers are obliged** to observe norms on labour safety, to carry out written and oral orders and instructions of the employer according to his powers. The basic duties of a worker are: honest work, submission to rules of the labour schedule, performance of the work norms and maintenance of quality of manufactured production, observance of the demands on labour safety, use of individual protection, careful relation to property of the employer, taking a step to injury prevention, maintenance of equipment and devices in the serviceable condition, order and cleanliness maintenance on the workplace and in territory.

The officials guilty of abuse of work legislation, default of obligations of collective agreements and agreements of labour safety or hindrance of trade unions activity account disciplinary, administrative or criminal liability.

As a *disciplinary* responsibility the employer can apply the following summary punishments:

- ✓ remark,
- ✓ reprimand,
- ✓ strict reprimand,
- ✓ dismissal.

Administrative responsibility consists in amercement on guilty of abuse of work legislation.

Criminal responsibility provides imprisonment, correction works, penalty or dismissal from office.

For abuse of norms, rules, instructions and other statutory acts on labour safety workers also account *disciplinary, material, administrative, criminal liability.*

5. For successful work on labour safety realization **of labour safety management**, including preparation, acceptance and realization of decisions on realization of planning, organizational, sanitary-engineering, treatment-and-prophylactic and other actions on labour safety is necessary.

The purpose of labour safety management – is maintenance of safety, reservation of health and working capacity of a worker in the course of work.

Problems are training of workers on labour safety, propagation of labour safety questions, maintenance of industrial equipment safety, productions, buildings and constructions, normalization of sanitary-and-hygienic working conditions, maintenance with individual protection of workers, maintenance of optimum work and rest regime, organization of treatment-and-prophylactic service of workers, sanitary-consumer services of workers, and professional selection of workers for separate specialities.

Prognostic and retrospective management methods are used. **The prognostic method** allows prognosticating and preventing of the possible risks, and is defined as safety of object at all stages of industrial activity. Forecasting is based on studying of working conditions, industrial injury, professional and general morbidity caused by production factors. Forecast data serve for formation of the purposes and problems of labour safety management at the enterprise, in shops and on sites.

The combination of prognostic and retrospective methods is used in practice. **The retrospective method** analyzes taking place events, the reasons of the adverse phenomena are found out and corresponding managing actions are defined, which realization allows to reach more high level of safety.

The process of labour safety management includes the following stages: reception of the information on working conditions; decision-making by the managing organ; handing of managing action for management object; reception of the information on changes of the working conditions caused by managing action; the analysis of working conditions in comparison with regulating criteria.

The government management in the field of labour safety includes the state supervision and the control on observance of the labour safety legislation, public examination of working conditions, assistance to public control of observance of the rights and interests of workers in the field of labour safety at production, interaction and cooperation of state bodies with employers and trade unions, protection

of interests of the workers who suffered from accidents at production or have received occupational diseases, and also members of their families.

In the control system of labour safety management at enterprises **the work protection service** takes the important place. The work protection service is introduced by the department of labour safety which is independent organization department of the enterprise and subordinates to director or chief engineer.

The problem of labour and health safety of women in the Republic of Belarus is actual as many chemical, biological and physical factors of working environment have negative influence female organism. Contact of working women to harmful substances and physical factors in pregnancy is especially hazardous, as at this time the importance of influence of production factors on an organism essentially increases.

According to the list of laborious work and work with harmful working conditions application of women work at certain works is forbidden.

Presence on a workplace of harmful and dangerous chemicals of the 1st and 2nd classes of hazard, pathogenic microorganisms, and also the substances possessing allergenic, gonadotrophic, embryotrophic, cancerogenic, mutagen and teratogenic action are contraindication for application of women work in childbearing age. It is not necessary to involve pregnant women for works at the height, demanding crossing through stairs. Application of women work in pregnancy is not supposed at works in a forced inconvenient working pose. Pregnant women should not carry out the labour operations bound to lifting of loads or subjects of work above level of her shoulder girdle, and also to lift subjects of work from a floor. Application of work of pregnant women at the works bound to prevalence of static tension of legs or prelum abdominale muscles is not recommended.

Women from the date of ascertainment of pregnancy and in breast-feeding of the child are not supposed to performance of all work kinds professionally bound to use of video display terminals and personal computers.

Limitations on employment of women: Women may not work in the following occupations:

✓ Mining or construction work underground, under water, in caves or tunnels or tunnels under mountains, except for work that does not cause injury to an employee's health or body.

✓ Work performed on scaffolding higher than 10 meters above ground.

✓ Manufacturing or transporting explosives or inflammable things, except where the working conditions do not cause damage to the employee's health or body.

✓ Any other job, as prescribed in regulations.

Protection for pregnant women: Pregnant women may not work in any of the following occupations:

✓ Work involving machinery or motors which have vibration.
✓ Work involving being in a moving machine or moving with vehicles.
✓ Work involving lifting, carrying, pulling, pushing, weights exceeding 50 kilograms.
✓ Work in ships or boats.
✓ Any other work, as prescribed in regulations.

Pregnant woman may not work from 10.00 pm - 6.00 am, or work overtime or work on holidays. Pregnant women who hold an executive, academic, administrative, financial or accounting position, may work overtime in a normal working day, providing that there is no effect to the employee's health, and with the employee's consent for each occasion of work.

Fringe benefits in labour legal relation are determined for non-adults below 18 years old. First of all, application of their work at works with laborious, harmful or hazardous conditions is forbidden. Non-adults are employed only after preliminary medical inspection and further, before achievement of 18 years old, annually are subjected to obligatory medical inspection. The reduced duration of operating time, interdiction for overtime, night and underground works, holiday not less than one calendar month, choice of a season for holiday, interdiction for unaccordance of annual holiday and work are provided for them.

Protection of child employment: Children aged under 18 may not work in the following workplaces:

✓ A slaughterhouse
✓ A casino
✓ Entertainment places, according to the law on entertainment places.
✓ Any other places, as prescribed in regulations.

Employers may not ask for or accept security from a child employee. An employer is not allowed to give wages of a child employee to anyone else. Where an employer gives payment or any other benefit to a child employee's parents, guardian or any person, in advance before employment, during employment, or before each occasion wage payment is due, it shall not be deemed that the payments are wages or that the employee receives wages, and it is not permitted for an employer who gave advance money or benefits to the child employee, to deduct it from his/her wages due.

6. Training, instructional advice and examination of workers concerning labour safety are the important elements of system of measures for prevention of failures and traumatism at production, maintenance of constitutional law of citizens on healthy and safe working conditions and have continuous all-level character.

Carrying out of instructional advice on labour protection and safety is one of obligatory conditions of the admission of workers to self-work. Instructional advices on labour safety are subdivided into:

- ✓ introduction,
- ✓ primary on a workplace,
- ✓ repeated,
- ✓ off-schedule,
- ✓ target.

Introduction instructional advice is made with all new workers irrespective of their education, work experience by the engineer on labour safety at labour safety office or specially conditioned premise equipped with means of training and visual aids on the program, developed by the protection work service and confirmed by the head. Instructed worker becomes acquainted with the general data on the enterprise, the typical features of production, rules of the labour routine, the general rules of behavior on the enterprise territory. The basic positions of the legislation on labour safety are explained to a worker, features of influence human body of dangerous and harmful production factors, demands of industrial sanitary science and hygiene, measures and individual protection, fire safety questions, ways and fire extinguishing are explained to a worker.

Notice about carrying out of introduction instructional advice is written in the log of introduction instructional advice with obligatory signatures of the instructed worker and the instructing officer, and also in the document on employment.

Primary instructional advice is made prior to the beginning of work with all new taken workers, and also changed of one sectioning to another; with the workers performing new work, the sent, time workers; with the builders who carries out building and assembly jobs in territory of the operating enterprise; with students and pupils who have arrived for industrial practice or training; before performance of new kinds of works under the programs developed and confirmed by heads of enterprises sectionings for separate trades or kinds of works.

Each worker individually or group of the workers serving the same equipment and within the general workplace, are instructed with practical display of safe receptions and work methods. Instructional advice is carried out directly on a workplace according to the confirmed program which considers features of production or carried out works and the demand of standard legal certificates on labour safety or according to the instruction on labour safety for the given trade or performed work.

Repeated instructional advice is for all workers with whom primary instructional advice was made. It takes place not more rare than once in a half-year.

At performance of the one-time works which have been not bound to direct duties on a speciality (loading, unloading, territory sweeping etc.); liquidations of consequences of failures, acts of nature and accidents; excursion carrying out at the enterprise, organization of mass actions with pupils (campaigns, sports competi-

tions etc.); production of works on which the order -admission or the permission is made **target instructional advice** is carried out.

Off-schedule instructional advice is necessary at consummation of the new or processed standards, rules, instructions on labour safety, and also changes to them; at change of technological process, replacement or modernization of the equipment, devices and instrument, a feed stock, materials and other factors influencing labour safety; at breaking by workers of safety requirements of work which could entail negative consequences; on request of supervision organs.

Instructional advices complete with oral interrogation or by means of training means, and also check of the got skills of safe operation. Notice about carrying out of primary instructional advice on a workplace, repeated, off-schedule, training and the admission to work is made in log of registration of instructional advice on a workplace with the obligatory signature of the instructed worker and the instructing officer.

Certification of workplaces on working conditions is a system of the registration, the analysis and the complex assessment on the specific workplace of all working environment and labour process factors, influencing health and working capacity of a worker in the course of labour activity. Improvement of working conditions is most effectively provided at studying of workplaces and their certification. All objects of economic activities are obliged to make certification of workplaces on working conditions not less often than once in five years (to execute the Law of the Republic of Belarus «About pensions provision ») according to the list «Kinds of works with harmful and (or) hazardous levels», confirmed by the Decision of the Ministry of Labour and Social Protection of the Republic of Belarus № 38 of 29.03.2006 y.

Workplace – is the spatial zone equipped with necessary means, including the primary and ancillary equipment, technological and organizational equipment, agents of maintenance of the favorable working conditions in which labour activity of the worker or group of the workers who are jointly carrying out production targets is made.

Certification provides:

- revealing of hazardous and harmful production factors forming an adverse work environment on a workplace, and also the reasons of their occurrence;
- assessment of technical and organizational level of a workplace on its conformity to standard legal certificates;
- research of sanitary-and-hygienic factors of industrial sphere, heaviness and intensity of labour process, quantitative assessment of working conditions on a workplace;
- working out and drawing up of the list of organizational-technical actions for improvement of working conditions;

- determination of the right of workers to an old-age pension according to Lists № 1 and № 2 of productions, works, trades, posts and the indexes granting the right to pension for work in special working conditions;
- establishment of surcharges, privileges and indemnifications for work in an adverse environment at the expense of the enterprise;
- drawing up of the list of the workplaces, productions, trades, posts, which workers on results of certification have the right to an old-age pension in connection with special working conditions according to Lists № 1 and № 2;
- drawing up of the list of the workplaces, which workers have the right of surcharges for work in an adverse environment;
- sizing of the differentiated tariffs (payments) on the state social insurance.

Workplace safety and health is a category of management responsibility in places of employment. To ensure the safety and health of workers, managers establish a focus on safety that can include elements such as:

- management leadership and commitment,
- employee engagement,
- accountability,
- ensuring all task are carried out safely and efficiently and effectivily,
- safety programs, policies, and plans,
- safety processes, procedures, and practices,
- safety goals and objectives,
- safety inspections for workplace hazards,
- safety program audits,
- safety tracking and metrics,
- hazard identification and control,
- safety committees to promote employee involvement,
- safety education and training,
- safety communications to maintain a high level of awareness on safety.

Hazard and risk assessment is made in a workplace. Hazard analysis or *hazard assessment* is a process in which individual hazards of the workplace are identified, assessed and controlled/eliminated as close to source (location of the hazard) as reasonable and possible. As technology, resources, social expectation or regulatory requirements change, hazard analysis focuses controls more closely toward the source of the hazard. Thus hazard control is a dynamic program of prevention. Hazard-based programs also have the advantage of not assigning or impling there are "acceptable risks" in the workplace. A hazard-based program may not be able to eliminate all risks, but neither does it accept "satisfactory" -- but still risky—outcomes. And as those who calculate and manage the risk are usually

managers while those exposed to the risks are a different group, workers, a hazard-based approach can by-pass conflict inherent in a risk-based approach.

Modern labour safety legislation usually demands that a *risk assessment* be carried out prior to making an intervention. It should be kept in mind that risk management requires risk to be managed to a level which is as low as is reasonably practical.

This assessment should:

- Identify the hazards
- Identify all affected by the hazard and how
- Evaluate the risk
- Identify and prioritize appropriate control measures

The calculation of risk is based on the likelihood or probability of the harm being realized and the severity of the consequences. This can be expressed mathematically as a quantitative assessment (by assigning low, medium and high likelihood and severity with integers and multiplying them to obtain a risk factor, or qualitatively as a description of the circumstances by which the harm could arise.

The assessment should be recorded and reviewed periodically and whenever there is a significant change to work practices. The assessment should include practical recommendations to control the risk. Once recommended controls are implemented, the risk should be re-calculated to determine of it has been lowered to an acceptable level. Generally speaking, newly introduced controls should lower risk by one level, i.e., from high to medium or from medium to low.

The map of working conditions on a workplace is the basic document at certification carrying out. All operating sanitary-and-hygienic and psychophysiological factors of a working environment, their actual magnitudes, corresponding to them standard values and points taking into account factors of duration of action are written in **the map of working conditions.**

There are common workplace hazard groups:

- **Mechanical hazards** include:

By type of agent: impact force, collisions, falls from height, struck by objects, confined space, slips and trips, falling on a pointed object, compressed air/high pressure fluids (such as cutting fluid), entanglement, equipment-related injury;

By type of damage: crushing, cutting, friction and abrasion, shearing, stabbing and puncture.

- Other **physical hazards**: noise, vibration, lighting, barotrauma (hypobaric/hyperbaric pressure), ionizing radiation, electricity, asphyxiation, cold stress (hypothermia), heat stress (hyperthermia), dehydration (due to sweating).

- **Biological hazards** include: bacteria, virus, fungi, mold, blood-borne pathogens, tuberculosis.
- **Chemical hazards** include: acids, bases, heavy metals, lead, solvents, petroleum, particulates, asbestos and other fine dust/fibrous materials, silica Fumes (noxious gases/vapors), highly-reactive chemicals.
  - Fire, conflagration and explosion hazards: explosion, deflagration, detonation, conflagration.
- **Psychosocial issues** include: work-related stress, whose causal factors include excessive working time and overwork, violence from outside the organization, bullying, which may include emotional and verbal abuse, sexual harassment, mobbing, burnout, exposure to unhealthy elements during meetings with business associates, e.g. tobacco, uncontrolled alcohol.
- **Musculoskeletal disorders**, avoided by the employment of good ergonomic design. Musculoskeletal disorders can affect the body's muscles, joints, tendons, ligaments and nerves. Most work-related musculoskeletal disorders develop over time and are caused either by the work itself or by the employees' working environment. They can also result from fractures sustained in an accident. Typically, musculoskeletal disorders affect the back, neck, shoulders and upper limbs; less often they affect the lower limbs. Health problems range from discomfort, minor aches and pains, to more serious medical conditions.

7. **Accidents** at production which are subjected to investigation – are traumas, physical injuries and other damages of the health which cause necessity of work change, temporary, not less than one day, disability, proof disability or death of the victim.

Traumas are caused by a sudden external mechanical, thermal, electric, physical or chemical action. Physical injuries can be caused by other persons, and also be received as a result of influence of animals and insects, explosions, failures, destructions of buildings, constructions and designs, acts of nature and other extreme situations.

On legal consequences for victim accidents are subdivided into industrial and household. Accidents are **industrial** if they have occurred during operating time, during an additional special breaks and time-out for rest and food, prior to the beginning and after the termination of works, at performance of works in an overtime, in days off, the state holidays and holidays, at following to a workplace or from work in transport, and also at going on foot or movement between objects of service or performance of the instructions of the employer, at performance of works on liquidation of extreme situations of natural and technogenic character and their consequences, at participation in public works registered in public service of employment, at performance of works on the civil-law contract in territory or out of territory of the insurer and under its control for safe conducting works.

Accident **in a life or a household event is** the accident which has occurred to the person during free time from work at performance of works in a house situation, on a summer residence and under other similar circumstances. On weight of consequences accidents are sectioned into accidents with lethal, serious outcome and without serious consequences.

Occupational diseases and accidents are subjected to investigation and registration. At investigation of occupational disease the professional standing of the victim, the circumstance and the disease reason, the responsible persons for immediate performance of rules of labour safety are found out by the commission, and also specific actions and terms of their performance on liquidation and prevention of the occupational diseases are specified. After investigation end the authorized official makes out the certificate about accident at production and refers it to the employer and the insurer for treating and statement. The certificate with investigation materials is stored within 45 years at the employer, the insurer and the organization at which accident is registered.

For intensifying of social protection of citizens, compensation of caused harm to life or health of workers, stimulation of economic interest of employers to professional risk decrease, improvement of working conditions. Since the 1st of January, 2004 **obligatory insurance** of accidents at production is entered in our republic. The sum of insurance payments is defined after the accident investigation at production.

The analysis of accidents gives the chance after revealing of the true reasons of this or that accident for search of paths of their exception or decrease. The analysis of accidents at production is made, as a rule, on certificates of investigation of accidents and temporary medical certificate.

Now two basic methods of the analysis of accidents - ***statistical and monographic, or clinical*** are used.

The statistical method of the analysis of accidents is based on the analysis of the statistical material which has been saved up for some years at the enterprise or in industry. It represents a set of methods, based on purposeful collection, storage and processing of information about accidents with the subsequent calculation of statistics. For this purpose accidents on certificates of investigation and other reports of the enterprises for the certain period of time are studied. This method allows to define dynamics of accidents, their heaviness at separate sites of production, in shops, at the enterprises or in industries and to elicit the patterns of their growth or decrease.

Group and topographical are kinds of the statistical method. **The group method** of the analysis allows to distribute accidents by kinds of works, hazardous and harmful production factors, data on victims (age, sex, standing, etc.), data about incident time (month, day, shift, hour of the working day). **The topographical me-**

thod consists in studying of the reasons of accidents in the place of their incident at the enterprise. Thus all accidents are regularly put by conventional signs on enterprise plans therefore the topogram is formed which visually shows the working sites and places with raised traumatic and dangerous situation.

The monographic method consists in the profound analysis of object of inspection in aggregate with all industrial situations. The technological and labour processes, equipment, applied devices and instruments, collective and individual protection are exposed to studying. The special attention is given to estimation of work and rest regimes of workers, line balance of the enterprise. The latent hazardous factors, capable to lead to accident, are revealed thus. This method can be used and for working out of actions for labour safety for again projected enterprises.

The economic method consists in definition of the losses caused by the accident, and estimation of social and economic efficiency of actions for their prevention.

Now other methods of the analysis of accidents - ergonomic, psychological, modelling are applied also.

In case of accidents, poisonings, traumas and sudden diseases **first aid** should be rendered victims. **First aid** – is a complex of the urgent actions referred on conservation of a life and health. First aid is provided at level of a self-care, mutual aid and collective help.

First aid is the immediate care given to victims of accidents before trained medical workers arrive. Its goal is to stop and, if possible, reverse harm. It involves rapid and simple measures such as clearing the air passageway, applying pressure to bleeding wounds or dousing chemical burns to eyes or skin.

The critical factors which shape first aid facilities in a workplace are work-specific risk and availability of definitive medical care. The care of a high-powered saw injury is obviously radically different from that of a chemical inhalation.

From a first aid perspective, a severe thigh wound occurring near a surgical hospital requires little more than proper transport; for the same injury in a rural area eight hours from the nearest medical facility, first aid would include-among other things-debridement, tying off bleeding vessels and administration of tetanus immunoglobulin and antibiotics.

First aid is a fluid concept not only in what (how long, how complex) must be done, but in who can do it. Though a very careful attitude is required, every worker can be trained in the top five or ten do's and don'ts of first aid. In some situations, immediate action can save life, limb or eyesight. Co-workers of victims should not remain paralyzed while waiting for trained personnel to arrive. Moreover, the "top-ten" list will vary with each workplace and must be taught accordingly.

Importance of First Aid. In cases of cardiac arrest, defibrillation administered within four minutes yields survival rates of 40 to 50%, versus less than 5% if given later. For chemical eye injuries, immediate flushing with water can save eyesight. For spinal cord injuries, correct immobilization can make the difference between full recovery and paralysis. For haemorrhages, the simple application of a fingertip to a bleeding vessel can stop life-threatening blood loss.

Even the most sophisticated medical care in the world often cannot undo the effects of poor first aid.

The provision of first aid should always have a direct relationship to general health and safety organization, because first aid itself will not handle more than a small part of workers' total care. First aid is a part of the total health care for workers. In practice, its application will depend to a large extent on persons present at the time of an accident, whether co-workers or formally trained medical personnel. This immediate intervention must be followed by specialized medical care whenever needed. It is not infrequent that several small incidents or minor accidents take place before a severe accident occurs. Accidents requiring only first aid represent a signal which should be heard and used by the occupational health and safety professionals to guide and promote preventive action.

What to do in an emergency: 1. Your priorities are to:

1. assess the situation – do not put yourself in danger;
2. make the area safe;
3. assess all casualties and attend first to any unconscious casualties;
4. send for help – do not delay.

2. Check for a response. Gently shake the casualty's shoulders and ask loudly, 'Are you all right?' If there is no response, your priorities are to:

1. shout for help;
2. open the airway;
3. check for normal breathing;
4. take appropriate action.

A. To open the airway:
- place your hand on the casualty's forehead and gently tilt the head back;
- lift the chin with two fingertips.

B. Breathing: Look, listen and feel for normal breathing for no more than 10 seconds:
- look for chest movement;
- listen at the casualty's mouth for breath sounds;
- feel for air on your cheek.

If the casualty is breathing normally:
- place in the recovery position;
- get help;
- check for continued breathing.

If the casualty is not breathing normally:
- get help;
- start chest compressions .

C. CPR: To start chest compressions:

- lean over the casualty and with your arms straight, press down on the centre of the breastbone 4-5 cm, then release the pressure;
- repeat at a rate of about 100 times a minute;
- after 30 compressions open the airway again;
- pinch the casualty's nose closed and allow the mouth to open;
- take a normal breath and place your mouth around the casualty's mouth, making a good seal;
- blow steadily into the mouth while

watching for the chest rising;
- remove your mouth from the casualty and watch for the chest falling;
- give a second breath and then start 30 compressions again without delay;
- continue with chest compressions and rescue breaths in a ratio of 30:2 until qualified help takes over or the casualty starts breathing normally.

Severe bleeding. If there is severe bleeding:

1. apply direct pressure to the wound;
2. raise and support the injured part (unless broken);
3. apply a dressing and bandage firmly in place.

Broken bones and spinal injuries. If a broken bone or spinal injury is suspected, obtain expert help. Do not move casualties unless they are in immediate danger.

Burns. Burns can be serious so if in doubt, seek medical help. Cool the affected part of the body with cold water until pain is relieved. Thorough cooling may take 10 minutes or more, but this must not delay taking the casualty to hospital. Certain chemicals may seriously irritate or damage the skin. Avoid contaminating yourself with the chemical. Treat in the same way as for other burns but flood the affected area with water for 20 minutes. Continue treatment even on the way to hospital, if necessary. Remove any contaminated clothing which is not stuck to the skin.

Eye injuries. All eye injuries are potentially serious. If there is something in the eye, wash out the eye with clean water or sterile fluid from a sealed container, to remove loose material. Do not attempt to remove anything that is embedded in the eye.

If chemicals are involved, flush the eye with water or sterile fluid for at least 10 minutes, while gently holding the eyelids open. Ask the casualty to hold a pad over the injured eye and send them to hospital.

Record keeping. It is good practice to use a book for recording any incidents involving injuries or illness which you have attended. Include the following information in your entry:

- ✓ the date, time and place of the incident;
- ✓ the name and job of the injured or ill person:
- ✓ details of the injury/illness and any first aid given;

- ✓ what happened to the casualty immediately afterwards (eg went back to work, went home, went to hospital);
- ✓ the name and signature of the person dealing with the incident.

This information can help identify accident trends and possible areas for improvement in the control of health and safety risks.

8. The questions surveyed in the lecture allow to conclude, that legal and organizational aspects of labour safety have great value for workers of health protection. The legislation in the field of labour safety is an essential element of creation of healthy and safe working conditions for working members of a society. In the Republic of Belarus management of labour safety is carried out both the state supervision and the control over performance of legislative and standard legal certificates on labour safety are made.

Workers have the right to healthy and safe working conditions and are obliged to fulfil the labour safety requirements. For work legislation violations the disciplinary, administrative or criminal liability is applied to the guilty.

At the enterprises training of workers on labour safety is made and certification of workplaces carried out also. Accidents at production are possible at violation of labour safety rules which are investigated and considered in accordance with established procedure, first pre-medical and medical aid is provided the victim.

LECTURE 2. BASES OF INDUSTRIAL SANITARY SCIENCE

Study questions

1. Introduction.

2. The sanitary requirements to objects of economic activities.

3. The sanitary characteristic of physical harmful production factors.

4. The sanitary characteristic of chemical harmful production factors.

5. The sanitary characteristic of biological harmful production factors.

6. The sanitary characteristic of psychophysiological harmful production factors.

7. Summary.

1. The purpose of industrial sanitary science is prevention of harmful influence of production factors on workers and preventive maintenance of occupational diseases. It solves **problems** on revealing of potential hazards and their sources, quantity and quality assessment of harmful production factors, and also working out of health activities for decreasing of harmful influence of production factors on workers.

Influence of physical, biological, chemical and psychophysiological harmful production factors on workers can lead *to disease, including occupational, and also to depression of working capacity and negative influence on posterity health.* Discrepancy to the sanitary rules and norms of lay-out, sanitary-engineering accomplishment and maintenance of factories, organizations, establishments and other objects of economic activities promotes harmful production factors influence on workers.

The basic **physical harmful production factors**: discomfortable microclimate, increased noise, vibrations, ultrasound and infrasound level, raised or decreased barometric pressure, increased level of electromagnetic, ionising, ultraviolet or laser radiations; **chemical** - organic, elementorganic and inorganic compounds in relatively small amounts; **biological** - pathogenic microorganisms and products of their vital activity; **psychophysiological** - physical and emotional overloads.

The diseases, originating exclusively or mainly as a result of influence on an organism of harmful production factors, are called **as occupational.**

Acute occupational disease is the disease which has originated from influence of a harmful production factor in the course of labour activity during no more than three shifts.

Chronic occupational disease is the disease which is result of long influence of a harmful production factor on a worker, entailed time or resistant disability.

Under the influence of harmful chemical substances **chronic poisonings** can origin at workers. **Chronic poisonings** originate gradually, at long regular influence of relatively small amounts of substance owing to its accumulation in an organism (material cumulation) or functional changes (functional cumulation).

For assessment of harm and level of safety of a chemical substance, a dust in air of a working zone **maximum permissible concentration** (MPC) - maximum concentration limit is standardized, which is maximum single. The maximum permissible concentration of a gas, vapour, spray or substance, is the concentration in the air at the place of work, which, according to the present state of our knowledge, in general remains without harmful effects on the health of both employees and their offspring, even after repeated exposure, during a longer period of time up to an entire working life.

The MPC is applied to healthy adults who work up to eight hours a day, interrupted by periods of rest in a non-contaminated atmosphere. Their working week does not exceed 40 hours and the nature of the work is not physically exhausting. Additional protective measures must be taken in the case of substances that are easily absorbed through the skin, and no other toxic substances must be present in the same room.

MPC values are regularly adapted as a result of new insights. Although you cannot determine the concentration of a particular substance at the place of work, the MPC does indicate how you should handle a particular substance. The concentrations of the substances that we use in laboratory settings will remain far below the MPC values. Nevertheless, the way you handle chemicals should be in accordance with the data found.

In the absence of the standardized value of maximum concentration limit **approximate safety level of influence** is used temporarily. For physical harmful production factors **maximum permissible level** (MPL) is standardized. Levels of exposure to harmful factors of workers are normalized to the maximum permissible level, whose values are listed in appropriate standards of safety standards and hygiene rules. Limit value of harmful factors - is the limiting value of the harmful production factor, whose impact on the daily regulated during the entire duration of work experience not reduces efficiency and disease both during labor activities, and to the disease in the subsequent period of life, and not adverse impact on the health of offspring.

Protection against harmful production factors involves technological, sanitary-engineering, planning and organizational actions, and also application of individual and collective protections.

Industrial sanitary science studies sanitary requirements to objects of economic activities, and also questions of the sanitary characteristic of physical, chemical

ical, biological and psychophysiological harmful production factors and protection against them.

The knowledge of questions of industrial sanitary science has great value for preparation and further labour activity of doctors as allows keeping health, to prevent influence of harmful production factors and to warn origin of professional pathology.

2. The sanitary requirements concerning **territory, internal lay-out, furnish, equipment, sanitary-engineering devices and maintenance** are made to objects of economic activities.

The territory must be of sufficient size, placed on dry, well aerated and insolated ground with low location of subsoil waters on 50-1000 m distance from a residential zone. Building area of territory must make 20-65 %, gardening area - not less than 15 % of all ground.

Objects, their separate buildings and constructions with the engineering processes which are sources of influence on human environment and health are divided with **sanitary-protective zones** from a residential zone.

Sanitary-protective zone - a part of territory around any source of chemical, biological or physical effects on human environment, which is organized with the purpose of risk minimization of adverse factors effects on human health.

The territory of objects must be kept clean and order, be lighted in dark time of days. Passageways and passages, and also gardening area must not be blocked up or used for storage of raw materials, products and production wastes, building and other materials, garbage, fallen foliage. On territory technological pits are necessarily fenced, grass of gardening area is mowed in due time.

Entrance and exit, highways, foot-pathes must have a firm covering, be repaired in due time and cleared as far as it is polluted. In winter time passages and pathes are necessary for strewing with nonslip means, roofs of buildings in due time to clear of an ice covering. Water drains, shower sewerage and system of superficial shower reservoir must be cleaned and repaired regularly.

On territory **zones** ***of engineering buildings, office buildings, warehouse, economic*** are divided. On gardening area rest zone is organized.

Buildings of factories, organizations and establishments must have the certain set of premises. **Office, industrial, auxiliary and sanitary-household premises** are provided at objects structure.

Premises and sections with harmful production factors are placed at exterior walls of buildings, in the isolated premises or cabins usually in single-storey buildings or on upper floors of multistorey buildings.

At works in which there is opportunity of harmful chemical substances penetration on skin and mucous hydrants and fountains for washing of eyes are arranged.

Wardrobes, washing stands, shower cubicles, rest rooms, food rooms, rooms of personal hygiene of women, health units, catering premises, inhalatoriums, fotariums, drinking water supply devices, premises for drying and clothes and shoes clearing, and also specialized laundries for washing and neutralization of overalls and special shoes are a part **of sanitary-household premises**. Drinking fountains and saturators are in corridors, buffet and other interfacing premises.

The finishing agents preventing sorption, admitting regular clearing, wet cleaning and disinfection, allowed to application by Ministry of Health of the Republic of Belarus, are applied for walls, ceilings and surfaces of premises.

The equipment mast have smooth surface, be serviceable, safety and resistant to the chemical, medicinal and disinfectant substances.

Objects are provided with ventilation, heating, illumination, water supply and solid and liquid waste clearing.

Industrial **ventilation** is a system of sanitary-engineering devices and constructions for decontamination from premises, supply of pure air and maintenance of optimum temperature, humidity and rate of air movement. Ventilation must be effective, safety, controlled rate, noiseless.

Classification of ventilation:

1. by *principle of operation*:

✓ local and general exhaust (air excision),
✓ input (air supply),
✓ exhaust - input;

2. by *character of dynamics*:

✓ natural,
✓ artificial;

3. by *organization:*

✓ providing organized and full exchange (exhaust - input natural, or aeration, and exhaust - input mechanical),
✓ providing organized, but partial exchange of air (recirculation),
✓ providing full, organized, stable exchange of air (air-conditioning).

Local exhaust ventilation restricts and deletes harmful substances in places of their formation and allocation (exhaust hoods, umbrellas). It is the most effective and economical way of excision of harmful substances, but in case of big surfaces of moisture, heat and toxic substances evolution its application is impossible. For compensation of deleted air local input ventilation is arranged.

General input ventilation fans air in more or less regular intervals along the full premise.

Exhaust - input ventilation is usually used, which not only exhausts polluted, but also submits pure air.

Natural aerating of premises is realized at the expense of temperature and pressure differences inside and outside of premises, artificial ventilation - at the expense of presence of mechanical stimulus of air masses.

Aeration of buildings is based on use of thermal and wind pressures and is more economic in comparison with mechanical systems of ventilation as does not demand electric power expenses while in service.

Recirculation represents variety of mechanical exhaust - input system in which partial return of exhausted air occurs for economy of heat on outside air heating. After clearing of harmful substances it is added to fresh outside incoming air.

Air conditioning is a creation and automatic maintenance of artificial simulated microclimate with additional easy ions and ozone saturation. It is possible to put in the air conditioner the program of optimum parameters of temperature, rate of air movement, humidity.

Ventilation emergency system is arranged in premises where disturbances of engineering followed sudden and appreciable toxic and explosive materials discharges are possible. As a rule, emergency ventilation is exhaust with emission of outcoming air. Compensation of air exhausted by emergency exhaust ventilation must be provided mainly at the expense of outside air.

Heating system is a complex of the equipment intended for reception, transport and transfer of warmth to warmed premises. It consists of the oscillator (source), the heat pipe-line, the heater. The heat transport is carried out by means of heat-transfer agent (heated water, steam, air).

Heating of premises must be regular, sufficient, uniform, not polluting a premise with gases, a dust, products of its decomposing on heated surfaces, noiseless, safety.

Heating **classification**:

✓ *local* at which all elements of heating are combined into one device and warm one premise (oven, gas, water, electric),

✓ *central* when a number of premises from one source is warmed (water, air, steam, radiant-panel).

Natural and the artificial **illumination** is designed at objects. **Natural illumination** is an illumination of premises by direct solar beams or diffused light. It must be uniform, stable, sufficient, without brightness. Depending on light direction lateral, overhead and combined daylight illumination are divided. Daylight illumination level in premises depends on geographical latitude of region, seasons and days, orientation of premises on parts of the world, shadow zone owing to opposing buildings or trees, sizes of windows, their form and design, purity and character of window glasses, paintings of ceiling and walls. Insolation regime depends on these factors. **Insolation regime** - a time of illumination of a premise by direct

solar beams which can be minimum (3 hours), moderate (3-5 hours) and maximum (more than 5 hours).

Artificial illumination on a functional purpose is divided into routine, emergency, evacuation and security.

Artificial match must be uniform, stable, sufficient, without brightness, its spectral distribution must conform to sunlight as much as possible.

At artificial match as light sources incandescent lamps and gas-discharge lamps are applied.

Incandescent lamps are simple at manufacturing, convenient at operation, do not demand additional devices for turning on in network system. Their disadvantages: low light transfer, visible radiation from incandescent lamps predominates in yellow and red parts of spectrum that calls distortion of the colour rendition, surrounding subjects. **Halogen incandescent lamps** have the best spectral distribution of light and good economic characteristics.

Gas-discharge lamps have illumination characteristics which meet the sanitary requrments more full. **Lamps of low pressure, or luminescent** are the most widespread gas-discharge lamps.

Light sources are equipped with fixtures which depending on luminous flux distribution can be of direct, diffused and reflected light. Use of fixtures **of direct light** allows to direct to the bottom hemisphere 80 % of a luminous flux. **Diffused light** fixtures direct to each hemisphere from 40 to 60 % of a luminous flux. They provide good uniformity of illumination at full absence of shades and are the most economic. Fixtures **of reflected light** direct to the overhead hemisphere not less than 80 % of all luminous flux, provide soft illumination without sharp shades. It is used for illumination of public buildings premises.

On a design fixtures are subdivided into:

- ✓ opened (the lamp is not separated from environment),
- ✓ protected (the lamp is separated by shell admitting easy access of air),
- ✓ closed (shell protects from inside penetration of coarse dust),
- ✓ dustproof (shell does not admit inside penetration of fine dust),
- ✓ dampproof.
- ✓ explosionproof.

Fixtures of **local** illumination must have protective armature which provides the 30 ° shielding angle for the purpose of the prevention of blinding effect. Fixtures of the general illumination are suspended at certain height.

General illumination is provided by means of the fixtures in regular intervals distributed on a premise. They are necessary for creation of sufficient light exposure at production facilities and passageways. Set of local and general illumination is **combined** illumination.

General artificial illumination of premises must be diffused. Combined illumination is arranged so that general illumination of a work surface make not less than 10 % of all light exposure, and general illumination in system of combined must give illumination level not less than 50 lux. Under such conditions there is no sharp contrast between light exposure of a work surface and entourage. Otherwise origin of visual discomfort and fast fatigability of eyes are observed.

There are internal **water pipe and sewerage** at industrial, auxiliary and sanitary-household premises for water delivery for industrial and economic-drinking needs and for export of sewage.

Economic-drinking (for supply of good-quality water for economic-household consumption) and **industrial** (for supply of technological and technical needs of a factory) water supply is equipped at objects.

Industrial water pipe can be direct-flow, consecutive and recycling. At **direct-flow water supply** all discharge water of manufacture is dumped back in a pond or directly into sewerage systems of settlements. At **consecutive water supply** water used on one manufacture, is turned to other manufactures then merged into sewerage. At **recycling water supply** used water is turned after necessary processing to manufacture. **Fire prevention water supply** represents set of technical means and devices providing water delivery for fire extinguish.

Water of used water sources must meet the sanitary requirements, agrees which organoleptic, chemical, microbiological parametres are standardized for underground sources. and organoleptic, chemical, sanitary, biological parametres - for surface sources.

Non-observance of sanitary requirements to drinking water supply conditions can be the reason of origination of epidemic flashes of acute gastrointestinal disturbance and expansion of helminthic invasions, disturbances of water-salt metabolism at workers of hot departments. Workers must be provided with good-quality potable water in quantity 5 dm^3 per the person in shift depending on character of manufacture and environmental conditions.

Water dispensation is made with the help of fountains, joined to a water supply system.

The great value **solid and liquid waste clearing** of objects has in labour safety.

Clearing of objects from waste is a complex of the planned sanitary, sanitary-engineering and economic actions directional for workers health protection and creation of favorable working conditions. It involves *collecting, disposal, neutralization and utilization* of solid and liquid waste.

Clearing from liquid waste is realized on export and floatable (sewerage) systems.

Receivers of sewage, drainage system, inspection shafts and treatment facilities are **sewerage system** basic elements. *Economic-household, industrial and shower* sewerage systems are provided, each of which can exist separately or in a combination with each other (combined sewerage system). Neutralization of the colloid and dissolved organic matters is made by the biological ways which can be artificial (biofilters, aerations filter, aeration tanks) and natural (fields of irrigation, filter bed) methods.

For the collecting and disposal of solid waste, in particular, household garbage **plan-household, or container** system is applied. Sections for dumps or production wastes are localized outside of a settlement territory and a security zone of water supply sources on separately dedicated equipped ground. Temporary storage of industrial wastes must be made on the special platform with firm covering warning pollution of adjacent territory. Collecting and storage of garbage containing a household and alimentary waste must be made on the dedicated fenced platforms with firm waterproof covering, equipped with garbage containers. Garbage containers are marked, equipped with densely closed covers and cleared in process of filling.

Neutralization of solid waste is made by soil way (composting) at which garbage are stacked with ground. At the expense of biothermal processes garbage is decontaminated, humified and then used as fertilizer. Technical ways such as garbage processing, burning also are applied to garbage neutralization.

Premises and equipment of objects of economic activities must be kept clean, be exposed to regular **cleaning and disinfection.** Current cleaning is made each shift by means of the centralized equipments or wet way. Tidying equipment are for separate cleaning of floors, walls, equipment, bathrooms and is accordingly marked. After tidying the equipment is processed and stored at specially organized premise.

3. Microclimate of industrial premises is determined by a combination of temperature, humidity, air mobility, temperature of surrounding surfaces and their thermal radiation. Heat have a significant impact on functional state of various systems of the body, health, performance and health.

Discomfortable microclimate most often meets as **physical** harmful production factor. **Microclimate** - a climate of the limited area. Comfortable microclimate has beneficial effect on health, and discomfortable (with high humidity at normal, low and high temperature), variable (at work on opened air), heating (with predominance of radiation warmth), coolling (with subnormal (from +10° to -10°C) and low (lower than -10°C) air temperatures) leads to disturbance of of heat exchange processes of organism.

Temperature of air and surfaces, relative humidity and mobility of air are key parameters of an industrial microclimate.

Temperature in the production facilities is one of the leading factors determining the meteorological conditions of the working environment. Air **temperature** is defined by quantity of warmth being in it. Biological effect of temperature is caused by influence skin thermo receptors. For the person the temperature 18-20°C is physiologically optimum at normal humidity and rate of air movement.

High temperature of air is observed in premises where processes are followed by appreciable heat releases (sterilization and autoclave rooms), low - at performance of works outdoor in winter and transition periods of year, and also in artificial cooled premises (refrigerating chamber and other thermal premises).

High temperatures have a negative impact on health. Work in conditions of high temperature is accompanied by intense sweating, which leads to dehydration, loss of mineral salts and water-soluble vitamins, causes severe and persistent changes in the cardiovascular system, increases the rate of respiration, and also affects the functioning of other organs and systems -- diminished attention, deteriorating of motor coordination, slowed reaction, etc.

Effects of thermal radiation on the organism has a number of features, one of which is the ability of infrared rays of different lengths penetrate to different depths and absorbed by the target tissue, providing the thermal effect, which leads to an increase in skin temperature, increase in pulse rate, changes in metabolism and blood pressure, diseases of the eye. Prolonged exposure to high temperatures, especially in combination with high humidity, can lead to significant accumulation of heat in body (thermal hyperthermia) with small temperature rise, headaches, nausea, vomiting, disturbance of light perception, and in serious cases - to heat stroke at which there is temperature rise up to 42^0, cramps, fall in blood pressure and sometimes convulsions, loss of consciousness are observed.

Low temperatures also affect internal organs, and long-term effect of these temperatures leads to their stable disease. Low temperature of air enlarges heat dissipation from surface of a body and, hence, promotes organism cooling, origination of angiospasm, fever, skin anaesthesia, numbness, tumescence of hand and foot fingers, frostbite. Cold can cause hypothermia leading to augmentation of acute catarrhal diseases or exacerbation of chronic bronchitis, myosites, neuritises, rheumatic disease, tuberculosis, pneumonia, etc.

Parameters of microclimate of industrial premises depend on thermophysical characteristics of the technological process, climate, season, the conditions of heating and ventilation.

Heated surfaces indoors are sources of **thermal radiation, or infra-red radiation** which represents the invisible electromagnetic radiation with wave from 0,74 to 2000 microns and possesses thermal properties. The intensity of heat radiation is measured in W/m^2. Infrared rays passing through the air is not heated but absorbed by solids, the radiant energy goes into heat, causing them to heat. Biolog-

ical effect of infra-red radiation is caused by warming-up of skin and tissues and largely depends on wave length and skin absorption capacity.

Humidity of air is defined by the quantity of water vapours in it. Humidity of air can be:

- ✓ absolute (quantity of water vapours in 1 m^3 air),
- ✓ maximum (quantity of moisture at full saturation of air at the given temperature),
- ✓ relative (the relation of absolute humidity to maximum, %).

Biological effect of humidity consists in influence thermoregulation. The relative humidity 50±10 % is physiologically optimum.

Mucous of nose, pharynx, mouth, eyes dry up at the relative humidity lower than 20 %. The relative humidity more than 90 % leads to stopping of sweat transpiration and organism superheating. High humidity reduces resistance of organism to tuberculosis, rheumatic and catarrhal sicknesses. Dry air is transmited by a human body easier, than crude.

Air movement indoors depends on thermal streams, act of outdoor wind, work of electric motors, cars, mechanisms. Its biological effect consists in influence baroreceptors, thermoregulation, breath processes, emotional condition, organism energy consumption. Rate of air movement 0,25 m/s indoors is physiologically optimum for an organism, having invigorating, tonic effect on an organism.

At high rate of air movement thermolysis by convection and sweat transpiration is increased, emotional condition is worsened, performance of physical work is at a loss. At low rate of air movement or absence of movement oppression of psychophysiologic condition is observed.

Working area must be provided with the parameters of microclimate, corresponding to the optimum and permissible values. Optimum and permissible values of microclimate parameters for a work zone of production areas taking into account the periods of year and class of works gravity are provided at objects.

Optimum microclimatic conditions provide general and local sensation of thermal comfort during 8-hour work shift at the minimum effort of thermoregulation mechanisms, do not cause health deviations, create preconditions for high level of working capacity and are preferable on work places. For example, during the warm period of year at performance of easy work of Ia degree optimum temperature parameters are 23-25°C, surfaces temperature - 22-26°C, relative humidity - 40-60 %, rate of air movement - 0.1 m/s; during the cold period - 22-24°C, 21-25°C, 40-60 %, 0,1 m/s. accordingly. Air temperature differentials on vertical, horizontal and during one shift must not exceed 2°C.

Permissible microclimatic conditions do not cause injuries or disturbances of human health, but can cause to origination of the general and local sensations of thermal discomfort, voltage of thermoregulation mechanisms, health state deteri-

oration and working capacity reduction. They are used in cases when for the proved reasons optimum parameters cannot be provided. At performance of easy work of Ia degree in the cold and transition period of year permissible microclimatic conditions must be the following: temperature 20-25°C, surfaces temperature - 19-26°C, relative humidity - 15-75 %, rate of air movement - 0,1 m/s, during the warm period - 21-28°C, 20-29°C, 15-75 %, 0,1 0,2 m/s, accordingly.

More often microclimate parameters make **joint impact** on an organism. High humidity of air in combination to low temperature has appreciable cooling effect, and in combination to warmth generates thermoregulations voltage, promotes superheating.

Air movement at high temperature makes more often positive impact on conservation of thermal balance of an organism, and at low - can lead to its cooling and supercooling.

High air temperature in combination to thermal radiation at physical work causes disturbance of water-salt balance, activity of nervous and cardiovascular systems, health state deterioration, and at strong superheating - to heat stroke.

Cooling and supercooling of workers are of influence organism of low temperatures in combination to high humidity and strong air movement.

Barometric pressure is defined by force from which air presses on earth surface and subjects being on it. Biological effect of barometric pressure is caused by immediate influence skin baroreceptors, vessels, psychophysiologic condition. Barometric pressure 760 ± 20 mm hg (1013 ± 26,5 hPa) is physiologically optimum.

Industrial noise is a set of sounds of various intensity and frequency, disorderedly changing in a time, originating under production conditions and causing at workers unpleasant subjective sensation. ***Decibel*** - a standard unit which shows, how much the given sound in logarithmic value more than conditional hearing threshold.

Noise health effects are both health and behavioral in nature. The unwanted sound is called noise. This unwanted sound can damage physiological and psychological health. Noise pollution can cause annoyance and aggression, hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances, and other harmful effects. Furthermore, stress and hypertension are the leading causes to health problems, whereas tinnitus can lead to forgetfulness, severe depression and at times panic attacks. Chronic exposure to noise may cause noise-induced hearing loss. Older males exposed to significant occupational noise demonstrate significantly reduced hearing sensitivity than their non-exposed peers, though differences in hearing sensitivity decrease with time and the two groups are indistinguishable by age 79. High noise levels can contribute to cardiovascular effects and exposure to moderately high levels during a single eight hour period causes a statistical rise in blood

pressure of five to ten points and an increase in stress and vasoconstriction leading to the increased blood pressure noted above as well as to increased incidence of coronary artery disease. Noise pollution is also a cause of annoyance.

Permissible sound level and equivalent noise level at management, creative, scientific, pedagogical, medical activity must not exceed 50 dBA, at measuring and analytical work at laboratory - 60 dBA, at dispatching work - 65 dBA, at remote control of production cycles - 75 dBA, at other aspects of works - 80 dBA.

Ultrasound is a meenanical oscillation of elastic medium with frequency above 16000-20000 Hz which are not perceived by ear. Biological effect of ultrasonic oscillations is caused by ability to penetrate into human body tissues, and sorbtion is increased and depth of penetration is decreases with frequency increase. Occupational exposure to ultrasound in excess of 120 dB may lead to hearing loss. Exposure in excess of 155 dB may produce heating effects that are harmful to the human body, and it has been calculated that exposures above 180 dB may lead to death.

Level of ultrasound transferred by contact way at frequency 8-63 kHz must not exceed 100 dB, 125-500 kHz - 105 dB, 1000-31500 kHz - 110 dB. Permissible level of ultrasonic pressure transferred by air way at medium geometrical frequency 12,5 kHz must not be above 80 dB.

Infrasound waves are widespread and now perceptible in the working environment (particularly in industry) as well as in the recreation grounds (natural sources of infrasounds). The main sources of infrasound include heavy machines. transport and materials handling installations, as well as natural phenomena, such as blowing winds, storms or flowing waters. Infra sound is a meenanical oscillation of elastic medium with frequency below 20 Hz.

Infra sound levels on a work place must not exceed 105 dB at frequency 2-16 Hz, 102 dB - 31,5 Hz.

At effect of intensive infra sound on a human body weakness, fast fatigability, working capacity depression, irritability are marked. Nervously-vegetative and mental disturbances, irrational fear, arterial pressure increase, syncopic state are observed in some cases.

It leads to malfunctioning and disorders of the respiratory, digestive, endocrine and nervous systems. These adverse impacts are revealed by disorders of the central nervous systems, characteristic of the lowered waking state. These changes are correlated with disorders of the respiratory and circulatory systems (reduced pulse rate and breathing rate). Physiological effects are treated as indirect consequences since they were first "processed" by the nervous system. The nervous system responds to infra- sounds as a "system", in other words, emotional effects coincide with vegetative effects. These effects are functional and hence passing:

trembling fingers, disturbed heart action. Physiological, metabolic, psychomotor effects are stimulated by the actions of the nervous system.

Vibration as industrial maleficence is a mechanical vibratory movements immediately transferred to a human body or its separate parts.

Vibration **classification**:

- ✓ general,
- ✓ local,
- ✓ combined.

General vibration is transferred through bearing areas to a standing or sitting human body. Depending on the source it is subdivided on technological, transport and transport-technological. Local vibration can be transferred from manual cars or hand tool, from cars and equipment.

Corrected and equivalent corrected levels of local vibration on vibration acceleration must not exceed 76 dB, on vibration speed - 112 dB. Corrected and equivalent corrected levels of general vibration on vibration acceleration must not exceed 50 dB, on vibration speed - 92 dB.

High levels of vibration cause originating of vibratory sickness in which neurotrophical and hemodynamic disturbances are basis. Weakening of skin sensitivity and expressed changes of central nervous, musculoskeletal and circulatory systems are marked at workers at effect of general vibration.

Ultraviolet radiation is an electromagnetic radiation in optical area in the range of 200-400 nanometers. Sources are gas-discharge light sources, electric arches, plasmatrons, lasers, bactericidal lamps.

Classification of ultra-violet radiation depending on wave length:

- ✓ A - long-wave (400-315 nanometers),
- ✓ B - middle-wave (315-280 nanometers),
- ✓ C - short-wave (280-200 nanometers).

Ultraviolet radiation with wave length 400-315 nanometers has weak biological effect. Ultraviolet radiation with wave length 315-280 nanometers are characterised by strong effect on skin (sunburn) and antirachitic effect. Ultraviolet radiation with wave length 280-200 nanometers posses bactericidal effect.

Intensive ultra-violet radiation of skin originates sunburn, promotes skin oncologic diseases, melanoma, speeds ageing and appearance of wrinkles. Effect of intensive radiation on eyes causes photoelectric ophthalmia witch characterized by feeling of sharp pain, sensation of sand in eyes, impairment of eyesight, cornea inflammation, lenticular opacity, cataract. The observable biological effects in man due to exposure from solar ultra-violet radiation are limited to the skin and to the eyes because of the low penetrating properties of ultra-violet radiation in human tissues. The penetration into skin is less than 1 mm and ultra-violet radiation is ab-

sorbed by ocular tissues (mainly the cornea and the lens) before it reaches the retina.

Ionizing radiation is an radiation which are capable to ionize environment directly or indirectly, that is ions of a different sign are formed in it. It is a stream of α - and β-corpuscles, neutrons, protons, γ - and X-radiation. Radionuclides, nuclear reactors, X-radiation apparatus are ionizing radiation sources. Organism radiation bombarding can be external when the radiation source is out of an organism, and internal - at radionuclides penetration in an organism through digestive tract, respiratory tract and skin.

Powers line, electric welding, television and radar stations, radiotelephones, computers are industrial sources **of electromagnetic fields,** or **electromagnetic radiation.** Biological effect of an electromagnetic radiation of the large intensity is bound mainly to thermal effect. Thus the blood flow to organs is increased, that protects them from excessive local superheating of tissues. Parts of a body with insufficient blood vessel (eye lens, testicles) are more sensitive to such local excessive heating.

Air ionization is a process of formation of electrocharged particles of the various nature. Various aspects of radiations are sources of industry air ionization. As a result of ionization easy negative and positive ions are formed.

Biological influence of negative easy ions consists in tonic effect on an organism, stimulation of metabolism, activity of central nervous system. Positive ions reduce an organism tonus, cause drowsiness, depression, increase arterial pressure. Minimum necessary level of aeroionization is 400 and 600, maximum permissible - 50000 and 50000 easy positive and negative air ions/cm^3.

Negative influence health of **computers** users is expressed in the raised visual voltage, emotional load, long invariable body position in the course of work, and also effect of some physical factors (electromagnetic radiation, static electricity, ultra-violet and X-ray radiations). The specified factors can be a cause of eyesight organs illnesses, cardiovascular system, digestive tract, skin diseases, and also brain tumours, etc. Children and pregnant women are subject to these dangers to the greatest degree. The symptom-complex of psychophysiological reactions of an organism of computer users at regular work is called as computer sickness or stress syndrome of display operator. Approximately half of computers users have complaints of this sickness.

Laser radiation is an optical radiation of a high power in certain narrow area of wave length. It can be oscillated in the range from 0,2 to 1000 microns of waves lengths.

Its biological effect is based on joint thermal and mechanical effect. Laser radiation predominantly causes injury via thermal effects. Even moderately powered lasers can cause injury to the eye. High power lasers can also burn the skin.

Some lasers are so powerful that even the diffuse reflection from a surface can be hazardous to the eye. Organ of vision is a critical organ for laser radiation. Dot eye cataract, eye grounds change, retina burn, inflammatory phenomena in conjunctiva, cornea, dark adaptation depression, blindness are observed.

The coherence, the low divergence angle of laser light and the focusing mechanism of the eye means that laser light can be concentrated into an extremely small spot on the retina. A transient increase of only 10 °C can destroy retinal photoreceptor cells. If the laser is sufficiently powerful, permanent damage can occur within a fraction of a second, literally faster than the blink of an eye. Sufficiently powerful in the visible to near infrared laser radiation (400-1400 nm) will penetrate the eyeball and may cause heating of the retina, whereas exposure to laser radiation with wavelengths less than 400 nm and greater than 1400 nm are largely absorbed by the cornea and lens, leading to the development of cataracts or burn injuries.

Cope with the adverse influence of industrial **microclimate** performs using the technological, sanitary and health and preventive measures. In preventing of the harmful effects of high temperature, infrared radiation technological measures such as replacement of old and introduction of new processes and equipment, automation and mechanization of processes, remote control have leading role. The group of sanitary and technical measures is the means of localization of heat generation and thermal insulation to reduce intensity of heat radiation and heat from the equipment.

Mechanization of labour processes, remote control, equipment removal on open areas from departments, thermal insulation of equipment surfaces, convective and radiant heat protectors, rational ventilation, air-conditioning, rationalization of work and rest regimes, rational drinking regime, and individual protection must be organized for **protection against superheating**.

Platforms, air curtains, double glassing of windows, warming of fences, floors, doors are installed for struggle against **cooling** at an entry in a premise. Planning of premises, rational heating, ventilation, overalls has great value. Preventive measures against the adverse effects of cold must include the delay of heat - a warning of cooling production premises, selection of rational regime of work and rest, use of personal protective equipment, as well as activities increase the protective forces of organism.

Use of the oxygen apparatus at works at 10-12 km height, cabin hermetic sealing, mechanization and automation of industry processes at works in the conditions of high mountains, training in pressure chambers, physical preparation and hardening, proper diet, rational work regime, medical services of persons with good health are the basis of **altitude sickness prevention**. The correct organization of decompression, medical control over a health state of the persons working at raised barometric pressure are important for prevention of possible **aeroembolism**.

Protection against vibration involves improvement of manual vibrating tools, manufacturing application of the equipment and processes with remote control, use of vibration insulation and vibration absorption means, timely repair of cars, exclusion of workers contact with vibrating surfaces outside of a work place, equipment of constant work places with amortization seats, rational work and rest regime, regulation of breaks, use of individual protection (gauntlets, gloves, shoes), vestibular apparatus training. Physiotherapeutic procedures which involve baths for hands, massage, ultra-violet radiation, industrial gymnastics have a special role in preventive maintenance of vibratory sickness. Sessions of psychological relief, rest in dispensaries, vitamins C, B_1, nicotinic acid are recommended to workers.

Elimination of the reasons of origination or its depression in a source and in transfer devices, perfection of production engineering, working out of noise safety engineering, rational planning of premises, optimum work and rest regime, regulation of work of the noisy equipment, inhibition of overworks and direct contact to a working surface of a ultrasound source are of great importance for **protection against noise**. Hum eliminating filters, helmets, inlays are applied as individual protection of workers from noise.

Various technical ways and means - shielding of emitters, premises and work places, decrease of voltage level and energy flow density in a working zone, use of attenuators, application of load equivalents and individual protection are recommended to apply for protection of the personnel against **electromagnetic radiation**.

Duration of regular work must not exceed 25 mines for **prevention of harmful effect of a computer** on the personnel. You should take away your eyes from the shield each 10 mines in 5-10 second. The complex of exercises for improvement of eyes functional condition should be spent at the first signs of eyes fatigue.

Placement of computers must exclude the cross radiation of workers.

Duration of work with the computer depends on in the presence of skills and difficulty of work and makes: for students of 1 course - 1 h; for students of older courses - 2 h with 15-20 min break; for computers operators - 6 h with 20 min every 2 hour break; for teachers - 4 h with 15-20 min every 2 hour break.

The collective and individual ways such as rational from the safety point of view placement of work places and laser equipment, leave for work of the persons passed special instruction, medical examination, instructional advice, obligatory separation or fence of laser danger zone with the disciplinary barriers, placement indoors no more than one laser, direction of a laser beam on fire-resistant and non-reflecting wall, painting of premise surfaces in colors with small reflectivity factor are applied to protection against **laser radiations.**

Eye and face protections (goggles, guards, attachments), arm and hand protections, overalls are individual protection applied at work with the open laser equipments.

Many scientists involved with lasers agree on the following guidelines:

- Everyone who uses a laser should be aware of the risks. This awareness is not just a matter of time spent with lasers; to the contrary, long-term dealing with invisible risks (such as from infrared laser beams) tends to reduce risk awareness, rather than to sharpen it;
- Optical experiments should be carried out on an optical table with all laser beams travelling in the horizontal plane only, and all beams should be stopped at the edges of the table. Users should never put their eyes at the level of the horizontal plane where the beams are in case of reflected beams that leave the table;
- Watches and other jewelry that might enter the optical plane should not be allowed in the laboratory. All non-optical objects that are close to the optical plane should have a matte finish in order to prevent specular reflections;
- Adequate eye protection should always be required for everyone in the room if there is a significant risk for eye injury;
- High-intensity beams that can cause fire or skin damage (mainly from class 4 and ultraviolet lasers) and that are not frequently modified should be guided through tubes;
- Alignment of beams and optical components should be performed at a reduced beam power whenever possible.

Decrease of radiation intensity of a source, source or work place shielding, use of individual protection, medical-and-prophylactic actions are the basic ways and protection means from **infrared radiation**. The thermal insulation with usage of mineral wool, glass wool, felt is applied to prevention of burns at a contact to heated surfaces. Headpieces, goggles, head masks with folding shields are applied as individual protection. Protection against **ultraviolet radiation** consists in application of overalls and goggles with various extent of transparency. Plexiglass and heavy glass containing litharge in the thickness of 2 mm and more provides full protection from ultraviolet radiation on all spectrum.

Harmful effect **of ultrasound** on a human body can be eliminated or lowered by raise of working frequencies, application of soundproofing casings and shields, mechanization and automation of processes, ultrasonic technological equipment remote control. Instruction, instructional advice, rationalization of work and rest regime are of great importance. Protection against ultrasound at contact affecting consists in adoption of the measures excluding workers contact with a source. At regular work with contact ultrasound during more than 50 % of operating time through every 1,5 h it is necessary to arrange 15-minute breaks. During the time it is possible to be engaged in a work which has been not bound to ultrasound.

Protection against **ionizing radiation** involves performance of safety requirements at factories placement, organization of workrooms and work places at work with closed and opened sources, in transport, storage and burial of radioactive substances, performance of general and individual radiation monitoring, observance of the standardized levels. Distance and time protection is realized, individual protection and protective shielding are applied. The essence of principle of time protection consists in decrease of operating time with a source, quantity - in decrease of radiated power of a source. Distance protection consists in increase of distance from a source to a worker, shields - in application of the materials absorbing an ionising radiation. Walls, floor and ceiling coverings, doors, inspection holes are stationary protective shields. Screens and shields made of special materials, containers for transportation and storage of radiation sources are mobile protection devices.

Dust is the most common adverse factor of industrial environment, multiple processes and operations in industry, transport, agriculture, accompanied by formation and emission of dust. **Dust** - a physical condition of substance in the form of the smallest firm corpuscles. The aerosol is a suspended dust in air. **Industrial dust, or aerosols** are the finely dispersed corpuscles formed at various industry processes and capable to be in air in a suspension for a long time.

Classification of industrial dust by origin:

✓ decomposition dust formed at blending, crushing and other mechanical processes,

✓ condensation dust formed as a result of cooling and condensation of steams of molten metals, glass mass, melts of salts, pregnant solutions;

by composition:

✓ organic,

✓ mineral,

✓ mixed;

by degree of dispersion:

✓ visible with corpuscles more than 10 microns,

✓ microscopic with corpuscles to 0,25 microns,

✓ ultramicroscopic with corpuscles less than 0,25 microns;

by character of effect:

✓ irritating (mineral, metal, wood, polymeric),

✓ toxic (a dust of chemical substances).

Dust corpuscles can effect a human body, penetrating in it through breath organs, digestive tract and intact skin.

At deep penetration of corpuscles of some kinds of microscopic and ultramicroscopic dust through lungs into lymphatic glands lungs disease can originate

which is named **dust diseases (pneumoconiosis)** (fig.1). Industrial dust also can cause diseases of eyes, upper airways, bronchuses, skin.

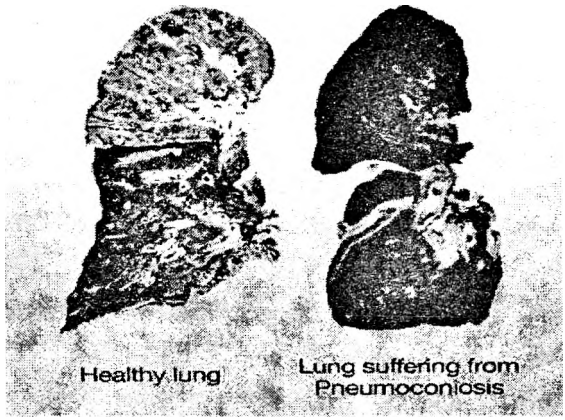

Fig. 1. Healthy and suffering from pneumoconiosis lungs.

Rationalization of processes on dust generation elimination, replacement of dry ways of dusting material processing for wet, use of hydro-and pneumatic transport in transit of dusting materials, conducting of technological and transport operations with remote control application, capsulation of industrial equipment, raw materials and products standardization, organisation of the regular sanitary control over a dustiness of air of a working zone, equipment of reliable ventilation of premises, rational planning of industrial, auxiliary both sanitary-household premises and their maintenance in purity are actions on **workers protection from harmful effect of a dust**.

At the raised concentration of a dust workers are obliged to use individual protection: overalls, gas-masks, respirators, goggles and others.

4. At engineering industry, agriculture, instrument making, aircraft, alimentary, chemical, pharmaceutical industry and medicine the processes based on use of various chemical substances, being to some extent harmful, are widely used. **Harmful** substance - substance which at contact to a human body in case of disturbance of safety requirements can cause diseases or deviations in health state, detected by modern methods both in the course of work, and in the remote terms of a life of the present and the subsequent generations.

Chemical harmful substances which under production conditions at penetration in an organism can cause acute and chronic poisonings, and also occupational diseases are called **as industrial poisons.**

Not leakproof equipment, insufficiently mechanized (automated) operations of loading of raw materials and unloading of finished commodity, repair works are sources of allocation of chemical substances. Chemical substances can arrive through input ventilation.

Character of effect of harmful substance is defined by its toxicity. **Toxicity is** a measure of compatibility of a poison with a life. Adverse working conditions can influence upon extent of toxic effect of industrial poisons. In particular, high or low temperature and barometric pressure, high humidity, noise, vibration reinforce toxic effect.

Danger of industrial poisons is possibility of origination of a poisoning on manufacture. Danger of a poison appreciably depends on its toxicity.

On danger harmful substances are subdivided into four classes:

- 1st class - **extremely dangerous** substances (vanadium and its compounds, cadmium oxide, nickel carbonate, ozone, mercury, lead and its compounds, terephthalic acid, tetraethyl lead, phosphorus yellow, etc.);
- 2nd class - **high dangerous** substances (nitrogen oxides, dichloroethyl, carbophosum, manganese, copper and its compounds, arsenious hydrogen, pyridine, sulfuric and hydrochloric acids, hydrogen sulphide, carbon disulfide, formaldehyde, fluoric hydrogen, chlorine, solutions of caustic alkalis, etc.);
- 3rd class - **moderately dangerous** substances (camphor, caprolactone, xylene, polyethylene of low pressure, sulphurus anhydrase, alcohol methyl, toluene, phenolum, furfural, etc.);
- 4th class - **low dangerous** substances (ammonia, acetone, benzine, kerosene, naphthalene, turpentine, alcohol ethyl, carboneum oxide, white spirit, dolomite, limestone, magnesite, etc.).

Extent and nature of substance influence organism depend on the path of contact with the organism, dose, exposure time, concentration of the substance, its solubility, the state of the receiving tissue of organism as a whole, atmospheric pressure, temperature and other characteristics of the environment. Consequences of harmful substances in the body can be anatomical damage, permanent or temporary illness and combined effects. Many strong acting noxious substances cause disorder in the organism of normal physiological activity without any significant anatomical damage, affect the nervous and cardiovascular systems, general metabolism, etc.

The basic ways of penetration of harmful substances into a human body are **inhalation** (through respiratory tract), **peroral** (through digestive tract) and **percu-**

taneous (through intact skin and mucosas). The most likely entry in body is substances in gas, vapor and dust inhalation (about 95% all poisonings).

Toxicant action on an organism can be **local and general**. Gases and pairs provoking irritation of nose, throat, bronchuses (prickling, dry cough) and eye mucosas (a pain, lacrimation) possess typical local action. General action of a poison originates at its penetration into blood and extension on all organism.

Industrial poisons can cause the **remote effects** which is appeared after many years after contact to them and in the subsequent generations. Sensitized, cancerogenic, mutagen, embryotoxic, gonadotrophic, hepatotoxic, nephrotoxic, cardiotoxic actions are the remote effects.

Harmful chemical production factors protection of workers from adverse influence involves rationalization of processes on elimination of steams and gases formation, replacement of harmful substances harmless or less harmful, maintenance of processes continuity, realizing of technological and transport operations under vacuum, all-round automation and mechanization of processes with remote control application, industrial equipment capsulation, use of gas analyzers and annunciators, bound to automatic system of protection.

Organization of effective ventilation of industrial and household premises, rational planning of objects, timely and qualitative cleaning of premises, standardization of chemical raw materials and products, work interchangeability has great value in system of protective measures. At the factories bound to use of chemical substances, regular control of air of working zone is conducted constantly.

Overalls, gas-masks, respirators, goggles and other individual protection are used in a case when it is not possible to lower concentration of harmful substances to safety level.

5. Biological harmful production factors can lead to origination of diseases and state of carrier caused by microorganisms - bacteria, viruses, ricketsia, spirochetes, funguses, actinomycetes, elementary and products of their vital activity, and also diseases caused by macroorganisms - animals, plants, humans and products of their vital activity at workers.

Pathogenic microorganisms can cause origination of infectious sicknesses of bacterial (tuberculosis, brucellosis), virus (ornithosis, furiousness), fungic (aspergillosis, actinomycosis), protozoal nature (coccidiosis, toxoplasmosis) and helminthiasis (trichinosis) at workers of agriculture and factories processing raw materials. Funguses and bacteria saprophytes cause allergic reactions.

Workers can be infected with staphilococcuses, streptococcuses, diphtheria bacteria, flu viruses by respiratory, tuberculosis bacteria – air-dust, bacteria of typhoid, cholera - water, dysentery bacteria - alimentary way. At medical institutions infection of the personnel from patients are possible.

For protection of workers against harmful biological production factors industry processes must be realized according to sanitary requirements, admit possibility of decontamination or neutralization of territory, premises, equipment, protection means, expel adverse effect of work methods with biological objects on workers.

Careful observance of process rules, maintenance of equipment hermiticity are necessary for prevention of occupational diseases at the workers occupied on antibiotics manufacture. Dust masks, goggles, gloves, hats are effective individual protection of workers. Medical workers also must use overalls (doctor's smocks, hats).

6. Psychophysiological factors are **work heaviness** which is defined by dynamic work, static load, working pose, body slope, moving in space, and **work intensity** characterized by efforts of attention, efforts of analyzer functions, emotional and intellectual load, monotony, interchangeability.

Increase of work heaviness at work in the forced, inconvenient working pose, and also at high load on musculoskeletal system can cause deformation of joints, origination of chronic arthritises, tendovaginitises, myosites, neuritises, muscle strength weakening, depression of muscles tonus and sense of touch disorder.

The forced pose at stand work usually causes to platypodia origination, varix dilatation. If stand work is followed by appreciable physical efforts inguinal hernia or omphalocele can origin. Deformation of pelvis bones with disturbance of organs position and complications at childbirth is possible at women in this case.

Scoliosis, lordosis or kyphosis of spinal column which are a consequence of effort of separate body muscles are originated as a result of regular sit work. The forced sit pose can cause also hemorrhoids, colitises and chronic constipations, disturbance of menstrual cycle at women.

The physical work bound to a load on musculation of arm fingers can cause coordination neurosises. Long pressure on joints, muscles, skin, bones often causes microtraumas, bursitises, neuritises.

Eyes fatigue which causes visual impairment to working day end occurs under the influence of the work bound to long eyesight efforts. Asthenopia with a pain in the field of orbits, obscure vision and headache often appears at work at a short distance with fine details. At advance asthenopia can cause spasm of accommodation, short-sightedness origination. Emotional and intellectual efforts can cause diseases of central nervous system, mental disorders, stress. Workplace stress can lead to: depression and anxiety, high blood pressure, joint and back pain, difficulty concentrating, mood and sleep disturbances, disturbed relationships (fig.2).

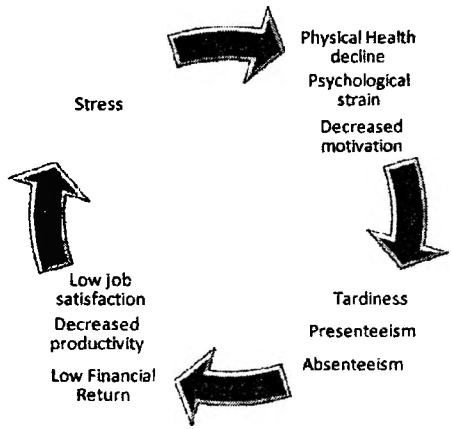

Fig. 2. The stress cycle.

Mechanization of manual operations, reduction of working day, restriction of admissible weight at lift and transport of loads, improvement of instruments, rational work regime, correct facilities of a work place, conducting of industrial gymnastics is of great importance for prevention of harmful effect of work heaviness. It is necessary to provide sufficient light exposure of a working surface for myopia preventive maintenance.

7. The bases of industrial sanitary science observed in the lecture are evidence of importance of the given part in labour safety of workers. The resulted data under the sanitary characteristic of the basic harmful industrial physical, chemical, biological and psychophysiological factors show, that at optimum value or value, lower, than the maximum permissible, specified factors do not cause functional and structural disturbances in workers' organism, do not reduce their working capacity and do not cause diseases. At the same time the deviation of optimum parameters in this or that side or excess of maximum permissible value of factors can cause a professional pathology of workers in the form of occupational disease in the acute or chronic form.

Technological, sanitary-engineering, planning and organizational actions are developed for protection of workers against harmful influence of production factors at objectss. Individual protection is applied in a case when by means of the given protection it is not possible to lower level of the harmful factor to maximum permissible value.

LECTURE 3. ACCIDENT PREVENTION BASES

Study questions

1. Introduction.

2. Prevention of dangerous effect of production factors, causing traumas, acute poisonings, sudden acute health deteriorations.

3. Work safety at maintenance of electrical installations and affecting of static electricity.

4. Accident prevention at maintenance of the vessels working under pressure.

5. Work safety at materials handling.

6. Safety requirements at maintenance of medical apparatus.

7. Accident prevention at work with biological objects.

8. Summary.

1. Accident prevention develops safety working conditions at work with electrical installations, at affecting of static electricity, at maintenance of the vessels working under pressure, at materials handling, at work with medical apparatus and biological objects.

Accident prevention **purpose** is a reduction of injury and death of workers from accidents, failures, catastrophes. For achievement of this purpose accident prevention solves following **problems**: revealing of potential dangers and their sources, quantity and quality assessment of dangerous production factors, and also working out of measures complex on maintenance of safety working conditions of workers.

Moving cars. mechanisms, products, cargoes, destroyed designs, spews and roughnesses on equipment surfaces, instruments and preparations, work place at a height, electric current, static electricity, ionising radiation are **physical dangerous production factors**; high concentration of organic, elementorganic and inorganic compounds - **chemical**; pathogenic microorganisms, affecting of macroorganisms and products of their vital activity - **biological**, physical and emotional overloads - **psychophysiological**.

Dangerous production factors result in *a trauma, acute poisoning or sudden acute health deteriorations or death* of workers.

Knowledge of questions of accident prevention is very important for preparation and further professional work of doctors as allows keeping health, to prevent influence of dangerous production factors and to warn origin of injury and death of workers.

2. Influence of dangerous production factors on workers can cause industrial injury. **Industrial injury** is a injuries of any character received at production

works. Cars, mechanisms, products, preparations, cargoes, destroyed designs, acute ridges, spews and roughnesses on equipment surfaces, instruments and preparations, work place at a height, electric current, pressure vessels, hot or cold surfaces, chemicals, macroorganisms can cause traumas at workers.

Trauma is a disturbance of anatomic integrity or physiological functions of human tissues or organs. Most often met traumas are mechanical traumas with tissues injuries (wounds, contusions, fractures, implantation of foreign particles). Insignificant traumas in the form of grazes or cuts are named ***microtraumas***. Thermal traumas in the form of burns, frostbites injuries originate from contact with hot or cold surfaces, combustible liquids, steam, liquid nitrogen, chemical - at work with concentrated acids and alkalis. Traumas of eyes are the most dangerous as can cause loss of eyesight.

Processes which under certain conditions can pass in an uncontrollable condition and result in to failures, explosions, exhausts of dangerous substances, poisonings and mechanical equipment destruction are called **as potentially dangerous.**

Classification of injury **reasons:**

✓ ***organizational*** (absence or unsatisfactory realizing of instruction and instructional advice, absence of the work production draft, non-observance of work and rest regime, wrong work place organization, lack and disrepair of individual protection),

✓ ***technical*** (constructive equipment and instruments imperfections, imperfection of technology processes, signaling system and interlocks),

✓ ***sanitary-and-hygienic*** (high noise level, vibration and other physical factors, concentration of harmful substances in air of a working zone, irrational lay-out and sanitary-engineering accomplishment),

✓ ***psychophysiological*** (physical and emotional overloads, nervous and emotion overwork, inconsistency between working conditions and anatomy-physiological worker features, unsatisfactory psychological climate in collective).

Injury analysis has the important role in injury prevention which is made under certificates of accidents investigation and temporary medical certificates. The statistical method is used for the injury analysis which allows to count the frequency factor (the relation of total quantity of victims to average quantity of workers for the accounting period, measured in ‰ (parts per thousand)), severity factor (quantity of days of invalidity for one trauma), invalidity factor (quantity of days of invalidity per 1000 workers).

Injury prevention involves automation and mechanization of technology processes, fence of moving parts of engineering tools and cars, rational organization of work and a work place, application of individual protection.

Technology process, serviceable condition of the equipment and instruments, working conditions, workers' instruction of safety rules are controlled.

The basic document regulating regime, hardware, order and norms of realizing of technology operations, safety service conditions, demands on environment protection and fire safety is **technological order**. Depending on a stage of production working out and degree of its development technological order is subdivided in laboratory, trial, triggering and industrial. Guilty is called to disciplinary and liability account for abuse of acting technological order.

Acute poisonings with chemicals more often occur as a result of failures, equipment breakages and gross breakdowns in process of accident prevention and are characterised by short-term effect and relatively high concentration of harmful substances. Poisoning symptoms are appeared at once or through rather short in several hours latent period. Prevention of acute poisonings involves complex of technological, organizational, planning, sanitary-engineering actions, application of individual protection.

High psychological overloads can cause sudden acute health deteriorations at workers in the form of **hypertensive crisis** with high arterial pressure to 260/120 mm hg and disturbance of brain and heart blood supply. Rational work and rest organization, mechanization and automation of technology processes, industrial music, benevolent relations in collective, psychological reliefs have great value in prevention of physical and emotional overloads.

3. Electric energy is one of the most convenient and economic kinds of power resources. It is equally widely used both on production, and in a life. Set of cars, apparatuses, lines and support equipment, intended for production, transformation, conversion, transmission, distribution of electric energy and its transformation to other kind of energy is called **electrical installation.**

At maintenance of electrical installations, the technology equipment with the electric drive, electric household appliances people are exposed to dangerous effect of electric current. To 85 % of lethal people injuries with electric current occurs as a result of a victim contact immediately to electric current carrying parts which are energized.

Principal reasons of electrical traumas at production are unsatisfactory organization of works on electrical installations, ignorance and no fulfillment of electrical safety requirements, non-user by workers of individual protection, discrepancy of electrical installations to the requirements of rules and norms.

Electric current effect on human has diverse character. Passing through human body electric current can cause thermal, electrolytic and biological effect.

Thermal current effect is displayed in the form of burns of separate body parts, heating of blood vessels, nerves, blood, plasma and other organic organism' substrates.

Electrolytic current effect is characterized by decomposing of blood and other organic organism' liquids therefore their chemistry and physical and chemical properties are changed.

Biological current effect is displayed in the form of irritation and excitation of living tissues of an organism that is accompanied by involuntary convulsive heart traction and lungs spasm and even full termination of activity of respiratory and blood circulation organs.

Electric current effect on human body can cause electric traumas and electric blows. **Electric traumas** are well-marked local lesions of a body caused by electric current effect, in the form of ***burns, electric signs, skin electrometallization, mechanical injuries and photoelectric ophthalmia***. In most cases electric traumas are treated, however at serious burns the lesion outcome can be lethal.

Electric burns are the most widespread electrotraumas. They are subdivided into *current, or contact, and arc*. **Current burn** originates at passage of the electric current with voltage not above 1-2 kilovolt through human body as a result of contact to a current carrying equipment part and is a consequence of transformation of electric energy to thermal one. Current burn causes a skin blushing or blistering, filled with turoid liquid (I- and II-degree burns). **Arc burn** originates at effect of higher voltage, thus between human body and a current carrying equipment part the electric arc with temperature above 3500°C and big energy is formed. Arc burns, as a rule, are more serious and cause a necrosis (carbonization) of all skin or even tissues, hypodermic cellular tissue, muscles, bones carbonizations (III – and IV - degree burns).

Electric signs are well-marked grey or pale yellow spots on skin, scratches, wounds, cuts, skin hemorrhages in a place of its contact to current carrying equipment parts. In most cases electric signs are painless and their treatment concludes safely.

Skin electrometallization - is infiltration into high layers of skin of the smallest parts of metals which has fused under the influence of an electric arc, and caused a skin burn. In the course of time the affected skin disappears, the site takes normal form, painful sensations disappear.

Mechanical injuries are results of sharp involuntary convulsive traction, resulting to ruptures of skin, blood vessels and nervous tissues, and also to dislocations of joints and even fractures.

Photoelectric ophthalmia – is eyes injure caused by intensive ultra-violet and infrared rays of an electric arc, and also penetration into eyes of molten metal splashes.

Electric blow is an excitation of live tissues of an organism by an electric current passing through it accompanied by consensual involuntary convulsive traction.

Heart arrest, respiratory standstill and electric shock can be causes of death as a result of electric current affection.

Heart arrest can occur owing to direct effect when the current proceeds through heart area, and reflex when the current passes through central nervous system. Cardiac standstill or disordered traction of heart and disturbance of blood circulation can be observed in both cases.

Respiratory standstill can be caused by direct or reflex effect of a current on thorax muscles participating in breath process. At long act of a current asphyxia originates. Asphyxia – is a disease state as a result of oxygen deficiency and carbon dioxide excess in human body. At asphyxia consciousness, sensitivity, reflexes are consistently lost, then breath and heart are stopped, clinical depth originates.

Electric shock – is the serious nervously-reflex reaction of an organism accompanied by disorders of blood circulation, breath and metabolism. Shock state lasts from several tens minutes to 24 hours. After that full recovery or death of the victim because of full extinction of the vital functions can be came.

Electrosecurity is system of actions and means, directed on protection of workers against dangerous effect of an electric current. It is provided with the design of electrical installations, technical ways and means, organizational and technical actions. The basic electroprotective means are rational design of electrical installations which must have a fence of current carrying parts and provide protection of the personnel against contact with current carrying and moving parts. Protective earthing, neutral earthing, switching-off, potential levelling, electric network separation, system of protective wires, isolation of current carrying parts, low voltages, control of isolation, individual protection are used for protection against electric current affection at touching to metal not current carrying parts which can be energised as a result of isolation fault.

Wide use in all areas of economic activities of dielectrics and organic compounds (polymers, paper, solid and liquid hydrocarbons, petroleum derivatives, etc.) is inevitably accompanied by formation **of static electricity**. Static electricity - is set of the phenomena bound to origination, conservation and relaxation of free electric charge on a surface, in volume of dielectrics or on the isolated conductors.

Static electricity, along with fire safety, represents danger to workers. So, easy "pricks" at work with strongly electrified materials harmfully influence mentality of worker and can promote traumas on the technological equipment at certain situations. Strong spark discharges can result in to painful sensations. Unpleasant sensations caused by static electricity can be the reasons of origination of neurasthenia, a headache, bad dream, irritability, prickings in the field of heart. Besides, at constant passage through human body of small electrization currents adverse physiological changes in an organism, resulting to occupational diseases, are possible. Regular impact of electrostatic field of the high voltage level can

cause functional changes of central nervous, cardiovascular and other organism' systems.

The ill effects caused by the accumulation of static electricity range from the discomfort one experiences when touching a charged object, such as a door handle, to the very serious injuries, even fatalities, which can occur from an explosion induced by static electricity. The physiological effect of electrostatic discharges on humans ranges from uncomfortable prickling to violent reflex actions. These effects are produced by the discharge current and, especially, by the current density on the skin.

Use of artificial or synthetic fabrics for clothes also results to accumulation of charges of static electricity on human body. Synthetic fabrics can be charged to potential 15 kilovolt. Therefore current running through human body dressed in suit or overall from a synthetic fabric, can attain 3 microampere.

Protection against static electricity must be applied in all explosion- and fire-dangerous premises and zones of the open equipments. At the production organization it is necessary to avoid the processes accompanied by intensive generation of static electricity charges. The effective method of decrease of intensity of static electricity generation is the method of contact pairs consisting in selection of structural materials on dielectric transmissivity in such sequence, that any of them gets negative charge at contact with the subsequent material and positive - with previous one.

Means of collective protection against static electricity on act principle are divided into *earthing connections, neutralizers, moistening devices, antielectrostatic substances, shielding devices.* **Earthing** represents a deliberate electrical connection with land or its equivalent of metal not current carrying parts which can be energised. In some cases continuous tap of static electricity charges from arms of the person can be carried out by means of the special earthed bracelets and rings.

Neutralization of charges of static electricity is made with radioisotope, combined, producing a stream of ionized air and corona discharge neutralizers. For decrease of specific superficial electrical resistance of dielectrics it is possible to raise relative humidity of air to 65-70 % if it is admissible on production conditions. At explosive productions for prevention of dangerous spark discharges of static electricity flowing of these charges into ground through conducting floors are provided. Special electrostatic shoes and clothes are individual protection from static electricity.

4. At objects of economic activities a considerable quantity **of the vessels working under pressure** is used. These are autoclaves, air vessels, preheaters, evaporators, balloons for compressed and liquefied gases, belonging to the equipment with the raised danger.

The design of vessels must be reliable, providing safety at maintenance, and accessible to survey, purification, washing, blowing and repair. Only strong materials are applied for manufacture of such vessels. Each vessel after manufacture is subjected to hydraulic testing. For maintenance of safety external environment vessels are supplied with devices of pressure and environment temperature measurements, stop valves, safeguard valves, and in some cases - liquid-level gauges.

On each vessel or group of the same vessels the service manual is made, which is hanged out on work places and given out to personnel. Repair of a vessel and its elements in an operating time is not admitted. In an operating time in the terms regulated by the instruction and in due volume serviceability of armature operation, monitors and safeguard valves are checked. A vessel is worked out of work at excess of pressure above allowed level, disrepairs of safeguard valves, damage of basic elements, disrepairs of manometer gage, liquid-level gauge, depression of fluid level below the admissible level.

Balloons for compressed, liquefied and solute gases with capacity more than 100 dm^3 must have safeguard valves. Lateral nipples of balloons gates must have left-hand thread for the inflated with hydrogen and other burning gases balloons, and for the inflated with oxygen and other nonflammable gases balloons, - right-hand thread. Each balloons gate for toxic and burning gas must be supplied by stub with female pipe adapter.

Gates of balloons with oxygen must be screwed into material, free of fatty matters (foil, liquid soda-ash glass), must not have fatted or oiled details and gaskets. Breathing from balloons into containers with smaller pressure must be made through reducer intended only for this gas and coloured in proper colour. The chamber of low pressure of the reducer must have manometer gage and spring safeguard valve balanced on proper allowed pressure in container, through which gas is overflowed.

Balloons which are in operation must be exposed to periodic survey not less often than once in 5 years. Balloons which are intended for the gases causing corrosion (chlorine, phosgene, hydrogen sulphide, sulphur dioxide, hydrogen chloride) and also balloons for compressed and liquefied gases applied as a fuel for cars and other transport facilities are subjected to periodic survey not less often than once in 2 years. Established permanently, and also balloons established permanently on mobile means and balloons-vessels in which compressed air, oxygen, argon, nitrogen and helium are stored, and also balloons with dehydrated carbonic acid are subjected to technical survey not less often than once in 10 years.

Balloons with gas, established in premises, must be on distance not less than 1 m from hot-water radiators and other heating devices and furnaces, and not less than 5 m from heat sources with open fire. Warehousing in one premise of balloons

with oxygen and burning gases is forbidden. Inflated balloons must be stored in a vertical position. For protection from falling balloons must be positioned in specially conditioned sockets or be fenced by a barrier.

Warehouses for storage of balloons with gases are built as a one-storey building, with easy coverings and without garrets. Walls, partitions, coverings of warehouses for storage of gases are made of nonflammable materials. Windows and doors must be opened outside. Window and door glasses are made of dull or white colour. Height of balloon warehouse must be not less than 3,25 m from floor to bottom parts of roof covering. Floors of warehouses must be flat, nonslip, from the materials expelling a spark formation. In warehouses instructions, rules and posters on balloons exploitation must be hanged out. In warehouses for balloons inflated with gas, natural or artificial ventilation according to sanitary requirements of industrial factories designing are provided.

Moving of balloons at points of filling up and consumption of gases is made on accommodated for this purpose carts or by means of other devices. Transportation and storage of standard balloons with capacity more than 12 dm^3 must be made by stub with female pipe adapter. At transportation and storage of balloons with toxic and burning gases stubs with female pipe adapter are installed. At transportation balloons inflated with gases are necessarily protected from solar beams action.

5. Recently at objects of national economy various **materials handling equipment** is widely used: roadways and traveling-bridge crane, truck loaders, small-scale mechanization means. Materials handling equipment frequently is dangerous zone not only for service personnel, but also for other people. *Dangers* which people can be exposed in these conditions are mainly bound to inadvertent contact to equipment moving parts and possible blow by incident subjects at breakage of lifted cargo, at spill of its part, and also with falling of the equipment. crashs and collisions.

For maintenance of work safety it is necessary to define a dangerous zone and the reasons of its origination to reveal. Reach of mobile parts of cars and equipment at normal operating mode and in case of their falling or destruction, and also at falling of lifted or transposed cargoes are basic principles of definition of a dangerous zone.

End switches, automatically disconnected mechanisms, load-carrying capacity terminators, buffers, sound and light signalization, blocking devices are applied for maintenance of safety operation of materials handling equipment. Accessible moving or twirling parts of pick-and-place device mechanisms are fenced, workers' inadvertent contact to transposed cargoes and mechanisms at their travel is expelled, and also reliable hardness of mechanisms and auxiliary attachments is provided. Pick-and-place devices are supplied with remote control,

automatic devices of wind signalization and protection against wind pressure, stoppers and catchers intended for stoppage of lifted cargo.

Small-scale mechanization means (hoists, conveyors, blocks, motor-carts) are widely applied at objects of national economy, including at public health services organizations. Hoist is used for lifting and moving of cargoes. Conveyor is applied as a mean for transportation of cargoes on short distances or objects movement between consecutive stages on a line production at assemblage of moving object. Block is a wheel rotating round own axis with trough in which rope, chain or strap are placed and is used for lifting of small cargoes or force direction. Motor-carts are supplied with propellers and used for moving of cargoes on short distances.

6. Application of the achievements to medical practice such as multipurpose complexes and computerized systems with use of computer aids demands the new approach to maintenance of safety application of medical apparatus. Advanced medical apparatus necessitates of professional skill improvement of service personnel. Personnel is obliged to know and fulfil requirements of operational documentation, standards, instructions, rules, to possess necessary skills on medical apparatus operation for maintenance of own safety, and also a patient and environment safety.

All medical apparatus must have log, to be equipped by earthing, to be in working order. Metal cases and supports of medical electro apparatuses, including portable apparatus and preheaters, are subjected to protective earthing irrespective of a place of their placement and carrying out of physiotherapeutic procedure.

Solutions of medical products applied to physiotherapeutic procedures, must be stored according to demands. The medical products, relating to group of strong medicines of A and B list, must be stored in special cabinets under lock.

At physiotherapeutic branches and offices it is forbidden to carry out physiotherapeutic procedures using the electro apparatuses fed from air electric network at a thunder-storm. It is forbidden to touch any earthed metal subjects during carrying out of medical procedure with contact engaging of electrodes, to stay in zone of direct affecting of energy decimeter and centimeter waves at carrying out of physiotherapeutic procedures on remote diagnosis, to use wires with damaged isolation.

Mechanical injuries, electrical shock, ionizing, electromagnetic, infra-red, ultra-violet and laser radiation, chemicals affection can be observed at personnel operating medical apparatus and patients. «Safety regulations at maintenance of medical apparatus at public health services establishments» is the basic deed regulating safety of work.

At medical institutions use of adapter connectors and extensions at connection of medical apparatus are forbidden. Personnel is forbidden to check

working capacity of electro medical apparatuses at unadapted for operation premises, to eliminate disrepairs in the apparatus connected to network, to apply electric ovens with open spirals, electric heaters without protective fencing devices.

Possibility of falling or overturning of medical apparatus in process of operation must be expelled. Personnel must periodically check security of attachment of knots and details, functioning of accident protection devices, periodicity of medical apparatus maintenance works and if necessary to consult about maintenance of sufficient level of safety at technical workers.

At non-observance of rules on safety operation of medical apparatus by personnel **mechanical traumas** by moving parts because of overturning of apparatus, injury of the systems supporting patient and hung parts of instrumentation, as a result of explosions of inhalation narcosis apparatuses, vials at unloading of sterilizer after sterilization of solutions, the vessels which are under pressure, and in other cases are possible.

There is a danger of electric, thermal and chemical burns at carrying out of physiotherapeutic procedures. For prevention of electric burns it is necessary strictly to carry out directions for locating of electrodes, dosing of current strength and duration of affecting at electro procedures, and also carefully to observe technique of imposition of electrodes. Heat insulation of hot surfaces by means of mineral wool, glass wool, felt is applied for prevention of burns at touch to it. At use of quartz-mercury radiation sources patient' and nurse' eyes must be protected with special goggles with dark glasses. Care at work with acids. alkalis, liquid nitrogen is necessary for prevention of chemical burns.

Anaphylactic shock originates at patient' contact to medical products in case of his individual sensitivity. In some cases serious anaphylactic reaction can be even at carrying out of medicinal electrophoresis or inhalations. Prevention of anaphylactic shock consists in obligatory knowing at each patient of medicinal preparations individual sensitivity, especially antibiotics. In doubtful cases prescription of physiotherapeutic procedures is possible only after proper allergological tests.

At work with radiological and radiological instrumentation there is a danger **of ionising radiation**, resulting to origination of beam burns, beam cataract, acute radiation sickness.

Protection against external ionizing radiation involves protection in distance, time, shields, from internal irradiation - consists in exclusion of person' contact with radioactive substances in open kind, their penetration in organism through air of working zone, ionized water, nutrition, prevention of pollution with radioactive substances of hands, clothes, equipment and premise surfaces.

For protection against ionizing radiation of all body dressing gowns, hats, rubber gloves are applied. At works with isotopes of big activity overalls, film

chloral-vinyl aprons and oversleeves, glued dressing gowns are used. For hand and arm protection lead impregnated rubber gloves, feet - special plastic shoes, eyes - goggles with special glasses or goggles of the closed type with rubber half mask, respiratory organs - breathing masks, hose gas-masks, pneumatic suits and pneumatic helmets are used.

At operation **of apparatuses of ultrahigh and superhigh frequencies** functional condition of nervous and cardiovascular worker' systems is worsened. Operation of apparatuses with output power more than 100 W and with remote method of irradiation must be carried out in specialized premises or in shielding cabins for prevention of dangerous influence of ultrahigh and superhigh frequencies. Stay of personnel in direct radiation zone of centimetric and decimeter waves apparatuses is forbidden. Sizes and forms of irradiator must meet to irradiated body segment. For protection of patient' eyes at irradiation of head region application of special goggles is necessary.

At operation **of laser equipments, devices of infra-red and ultraviolet radiation** injuries of eyes and skin are possible. Basic actions on protection against harmful effect of infra-red, ultra-violet, laser and electromagnetic radiations on an organism are protection in distance, shields, special coloring of premises and rational placement of work places are applied. Plexiglass and glass with lead oxide of 2 mm thickness are provided the full protection from ultraviolet radiation.

As individual protection for prevention of harmful influence of laser radiation goggles with special light filters - orange, blue-green and others depending on wave length of radiation are applied; ultraviolet radiation - overalls, mittens, apron made of special cloths, guard with the light filter appropriating to a certain radiation intensity, goggles with dark colour of glasses with lateral protection (leather or rubber frame); electromagnetic radiation in emergency modes or at carrying out of short-term works - goggles made of the glass covered with semi-conductor tin dioxide and special clothes made of metallized cloth. For protection of skin the ointments with protective effect are used, and also overalls made of linen and cotton fabrics with sparkle resistant saturation and made of broadcloth are applied.

7. Large doses of a biological material are dangerous biological production factors: microorganisms (bacteria, viruses, ricketsia, spirochetes, funguses, actinomycetes), products of their vital activity, products of vital activity of macroorganisms, and also cell and tissue cultures. So, infection with pathogenic microorganisms or pathogens of extremely dangerous infections can cause fatal outcome. Injury of workers is possible at service of inadequate and sick animals and people, poisoning with poisonous plants, animals and their products is possible also.

Dangerous effect of biological factors is possible at use of medicinal products for preventive maintenance, treatment, diagnostic and other purposes in medicine, veterinary science and agriculture, use of microorganisms cultures, work in natural focuses of extremely dangerous infections and invasions, service of animals, work in places of dwelling of animals, service and training of animals in zoos and circuses, collection and processing of medicinal vegetative raw materials, wood harvest and forestry works, service and treatment of mentally diseased patients.

Safety of work at work with biological objects is provided with technological process, equipment, individual protection, system of special preventive actions, observance of work rules. Protection of workers against dangerous biological factors must be complex and consist of technological, organizational, sanitary-engineering, planning actions. Basic role belongs to the further perfection of processes, increase of work effectiveness of purification systems of plant emissions, strict observance of modes of packaging of polluters, maintenance of effective work of industrial ventilation, manufacturing application of nonwaste technology. Great value has carrying out of disinfection, disinsection and diratization actions, organization of work and rest mode, maintenance of workers with individual protections, overalls, strict observance of rules of personal hygiene.

8. The bases of accident prevention observed in the lecture are evidence of importance of the given part in labour safety of workers. The resulted data show that at operation of electrical installations, work with sources of static electricity, at maintenance of the vessels working under pressure, at materials handling, at work with medical apparatus and biological objects it is necessary to observe regulations of accident prevention. Violation of regulations of accident prevention can cause a trauma, acute poisoning or other sudden acute health deteriorations or death.

For protection of workers against dangerous effect of production factors at objects technological, sanitary-engineering, planning and organizational actions are developed. Individual protection is applied in a case when by means of the given protection it is not possible to lower level of the dangerous factor to maximum permissible value.

LECTURE 4. FIRE SAFETY BASES

Study questions

1. Introduction.
2. Theoretical bases of burning.
3. The characteristic of fire and explosive materials.
4. Fire safety at objects. Fire prevention.
5. Fire liquidation. The characteristic of fire extinguisher substances.
6. Means of fire extinguishing.
7. Supervision of fire safety. Organization of fire protection at objects.
8. Summary.

1. Fire and explosive risk of substances and materials is a set of the properties characterizing their ability to origination and extending of burning. The consequences of burning depending on its rate and behavior conditions are **fire** (diffusion combustion) or **explosion** (deflagration burning).

In the conditions of production **fire** is an uncontrolled, unauthorized burning of substances, materials and steam-and-gas mixtures out of the special fireplace, resulting a significant material damage and defeat of people;

explosion is a fast uncontrolled release at chemical or physical processes of energy which produces blast wave, moving on some distance from a source and resulting to destructions.

Flame and sparks, heat flow, high temperature of environment, high concentration of toxic combustion gases and thermal decomposition, low concentration of oxygen and visibility deterioration in a smoke are **fire dangerous factors** attacking people and property.

Blast wave, flame, breaking-down of constructions and scatter of members, formation of hazardous substances with concentration in air much more above maximum permissible one are **explosion dangerous factors**.

Depending on a sort of burning substances and materials fires are classified by classes:

A - burning of solid substances,
B - burning of liquid substances,
C - burning of gaseous substances,
D - burning of metals,
E - burning of electrical installations,
F - burning of radioactive materials and waste.

Fire and explosive safety is a condition of object at which fire and explosion possibility is as much as possible expelled, and in case of their origination impact on people of dangerous factors is prevented and protection of

stocks of materials and capital equipment is provided. Fires and explosions cause a significant material damage to national economy and in some cases provoke serious injuries and death of people. In the republic of Belarus on the average annually about 10 thousand fires and failures happen, about 100 persons die and more than 1000 injure.

Smoking, leavening without look of heating appliances, warming up of component parts in open fire and another negligent and careless handling of fire, disrepair of boiler rooms, heating appliances, furnaces and ventilation systems, disrepair of industrial equipment and breakdown in processes followed allocation of combustible gases, vapour, dust, spontaneous ignition or spontaneous combustion of some substances and materials at violation of rules of their storage and use, sparking in electric apparatuses, cars, currents of short circuits and heating of wires and windings of electric devices, bad contacts in places of wires joints resulting to allocation of a considerable quantity of heat, electric arc originating during arc electric welding or as a result of erroneous operations in electrical installations, electrostatic discharges, strokes of lightning are principal **causes of fires**. The most frequent causes of fires in electric devices and wiring are *overloading, short circuits, electric sparks and high contact resistances.*

Theoretical bases of burning, fire and explosive materials, fire extinguisher means are studied on fire safety, questions of prevention and liquidation of fires, fire safety organization are studied.

The knowledge of bases of maintenance of fire safety at objects is of great importance for preparation and further labour activity of doctors as allows preventing influence people of fire dangerous factors, to keep health and life of workers, and also to provide protection of stocks of materials and capital equipment.

2. Burning – is an intensive chemical oxidizing reactions which are followed by allocation of heat, smoke and light emission. Burning can originate only at simultaneous presence *of a inflammable, oxidizing agent and ignition impulse.*

Inflammables are any organic matters and materials, many metals in the free kind, some minerals, sulphur, carbon oxide, hydrogen, phosphorus, ***oxidizing agent*** - oxygen, perchlorates, nitro compounds, sodium peroxide compound, hydrogen nitrate, chlorine, ozone and other chemical compounds.

Ignition impulses are *opened, or luminous*, sources - flame, red-hot surfaces, radiant energy, sparks, and also *hidden, or not luminous*, sources - friction, blow, adiabatic compression, exothermic reaction.

Ignition Sources:

1. heat energy generated during chemical reactions (heat of oxidation, heat of combustion, heat of solution, spontaneous heating, heat of decomposition, etc.);

2. electrical heat energy (resistance heating, induction heating, heat from arcing, electric sparks, electrostatical discharges, heat generated by lightning stroke, etc.);

3. mechanical heat energy (frictional heat, friction sparks);

4. heat generated by nuclear decomposition.

Flame, or torch, is a space in which pairs and gases burn down. **Nonflammable burning**, or **smoldering** is characteristic for solid, liquid substances, their mixtures and other condensed systems.

Homogeneous burning, heterogeneous burning and burning of explosives are differed depending on an aggregative state of parent substance and combustion products.

Depending on rate of movement, or spreading, of flame on gas mixture burning can be *diffusive, kinetic* with some km/s rate, *deflagration, or explosive*, with tens and hundreds km/s rate and *detonation* with thousands km/s rate.

At **homogeneous burning** parent substances and combustion products are in the same aggregative states. This is burning of gas mixtures (natural gas, hydrogen, carbon oxide and other substances with air oxygen), burning of nongasificated condensed materials (thermits - mixtures of aluminium with oxides of various metals); isothermal burning (extending of chain reaction in gas mixture without a significant heating).

At **heterogeneous burning** parent substances are in different aggregative states. This is burning of solid or liquid combustible and gaseous oxidizing agent (coal, metals, liquid fuels in furnaces, internal combustion engines).

Burning of explosives is followed by transferring of substance from condensed into gaseous. Heat and combustible gases which are burning down in burning area on some distance from a surface are precipitated out on the phase boundary.

Diffusive burning is characteristic for chemically non-uniform combustible systems in which inflammable and air are not mixed and have surfaces of separation. The oxygen diffusion time to an inflammable is much more the time necessary for proceeding of chemical reaction and process proceeds in diffusive area. If the time of mixing of inflammables with oxidizing agent incommensurably less than time of proceeding of chemical reaction such process of burning is named **kinetic**.

Transfer of warmth from bed to bed is characteristic for **deflagration burning**, and flame originating in heated mixture, moves in initial gas mixture direction. Deflagration or explosive occurs at running up of flame spreading rate to 300-320 km/s.

Explosion, as a rule, is followed **by blast wave** origination – is an intensive pressure increase in environment. Blast wave possesses destructive ability if

overpressure exceeds 15 kPa in it. It spreads in gaseous area before flame front with 330 km/s sound speed.

Under certain conditions explosive burning can pass in **detonation** process at which flame spread exceeds the sound speed and is equal 1-5 km/s. **Detonation** is a process of chemical transformation of redox system, or formations of blast wave spreading with constant speed and exceeding the sound speed which follows front of chemical transformations' area of parent substances. At detonation mode of burning of vapour-gas-air mixer large part of explosion energy transforms in blast wave, at explosive burning energy transformation in blast wave makes about 30 %.

Combustion materials, which compound depends on parent substances and conditions of burning reaction, are formed as a result of burning. Carbon, sulfurs, nitrogen dioxides, water are formed at complete combustion of organic compounds, oxides - at combustion of inorganic compounds. Soot, hydrogen, carbonic oxide, methane, atomic hydrogen, oxygen, radicals, alcohol, aldehydes, ketones, formonitrile, furans are a part of products of incomplete combustion of inflammables.

3. Classification of fire and explosive materials:

- **gases** - the substances which pressure of saturated vapours at temperature 25°C and pressure 101,3 kPa exceeds 101,3 kPa;
- **liquids** - the substances which pressure of saturated vapours at temperature 25°C and pressure 101,3 kPa is less than 101,3 kPa and **solid consumable substance**, which melting point and drop falling is less than 50°C;
- **solid substances and materials** – the separate substances and their mixed compositions with melting point or drop falling more than 50°C and the substances which do not have melting points (wood, fabrics);
- **dust** – the suspended solid substances and materials with the particle size less than 850 microns.

On abilities to burning (combustibility) substance and materials are subdivided in:

- **nonflammable (incombustible)** – the substances and materials are not capable to burn in air;
- **difficaltflammable (difficaltcombustible)** – the substances and materials are capable to burn in air at impact of ingnition impulse, but not capable independently to burn after its removal;
- **combustible (combustible)** – the substances and materials are capable to ignite spontaneously, and also to ignite at impact of ingnition impulse and independently to burn after its removal.

Volatile flammable substances and materials, which are capable to be inflamed from short-term (to 30 sec) impacts of ignition impulse with low energy (match flame, spark, smoldering cigarette) are most significant of them.

The maximum burning rate is attained at stoichiometric concentration of substances, i.e. at concentration which precisely conforms to the quantities of the content substances combined with each other at burning reaction. *Concentration limits of flame spread* is the minimum or maximum content of inflammable in intimate mixture with oxidizing medium at which flame spread on mixture on any distance from ignition impulse is possible. *Temperature limits of flame spread* are temperatures of liquids at which concentration of saturated vapours in air over the liquid is equal to concentration limits of flame spread. *Ignition* area is the range between bottom and top concentration limits.

For ignition it is necessary, that the liquid was heated to temperature not less the bottom temperature limit of flame spread. After ignition of liquid vapours rate of evaporation must be sufficient for maintenance of constant burning. These features of liquids burning are characterized by flash and ignition points.

Flash point - the least temperature of condensed material at which in the conditions of special trials over its surface pairs are formed, capable to spark in air from an ignition source. Flash point conforms to bottom temperature explosive range.

Ignition point - the least value of liquid temperature at which its evaporation rate is that, that after ignition by an external source independent flame burning originates. **Self-ignition point** - is the lowest temperature of substance at which in the conditions of special trials there is a sharp speed enhancing of the exothermic reactions, finishing burning.

Liquids depending on flash point are subdivided in volatile flammable and combustible. **Volatile flammable liquids** - liquids with flash point no more than 61°C in shut crucible or 66°C in open crucible. For volatile flammable liquids ignition temperature ordinary is 1-5°C above flash point, and for **combustible** liquids this difference can be 30-35°C.

Maximum pressure of explosion and *rate of pressure rise at explosion* are the basic parameters characterizing **explosion hazard**.

Maximum pressure of explosion – is the greatest pressure originating at deflagration explosion of gas -, vapour - or dust-air mixture in a closed vessel at initial pressure of mixture 101,3 kPa.

Rate of pressure rise at explosion - is a derived quantity of explosion pressure in time on the ascending site of dependence of explosion pressure of gas -, vapour - or dust-air mixture in a closed vessel from a time.

Minimum energy of ignition - the least value of energy of electric discharge, capable to inflame the most easily flammable mixture of gas, vapour or dust with air.

Minimum explosive oxygen content or other oxidizing agent is necessary for explosion realization. It is such concentration in a gas mixture below which ignition and burning of mixture become impossible. Sensitivity of substance to blowa friction or other mechanical impact defines inclination to explosion and detonation. Mixtures of gases, vapours, dust with air, oxygen, ozone, chlorine, oxides of nitrogen and other oxidizing agents, capable to explosive transformation, and also some substances, inclined to explosive decomposition (acetylene, ozone, hydrazine, ammonium nitrate), are explosive medium.

4. Fire safety is condition of object at which fire possibility is as much as possible expelled, and in case of its origination impact on people of fire dangerous factors is prevented and protection of stocks of materials and capital equipment is provided. It is provided with the complex of the measures preventing fire origination, and fire protection system providing successful struggle against an originated fire or consequences of explosion.

Fire origination prevention is attained by exclusion of formation of combustible medium, sources of ignition, maintenance of temperature of combustible medium and pressure in it lower than maximally permissible one. Prevention of combustible medium formation is provided with regulation of admissible concentration of combustible gases, vapours and suspensions in air, and also oxygen or other oxidizing agents.

Application of nonflammable and difficaltflammable substances and materials, restriction of quantity of inflammables, fire spread prevention out of fireplace, application of objects constructions with the regulated limits of fire-resistance and combustibility, creation of conditions for people evacuation, application of people protection and system of smoke protection, application of means of fire alarm and means of fire notice, organization of fire protection at objects are **preventive measures**.

Fire spread prevention is provided with the device of fireproof walls, working areas, belts, protective strips, curtains and other barriers, application of the agents preventing or restricting of spilling and flowing of liquids at fire.

Organizational, operational, technical and regime actions are made for fire prevention at objects.

The correct organization of fire protection at objects, fire safety instructions for workers, carrying out of fireproof instructions and technical minimum, conversations, creation of voluntary fire-brigade, use of means of visual agitation are **organizational actions**. Each new worker must study the fireproof instructions, and at especially fire - and explosive dangerous factories all workers must study the

fire-technical minimum. Fireproof instruction is carried out in two stages - introduction and instruction on the work place. Fire-technical minimum is made in the form of classes on the special program developed taking into account fire risk features of the technological equipment. Detailed instruction of workers to means and ways of using of available individual protection, fire fighting and fire alarm are provided in this case.

Operational actions provide timely carrying out of routine inspections, repairs, trials of technological, auxiliary and engineering equipment, and also correct maintenance of buildings and constructions.

Strict observance of fire prevention rules at designing and construction of buildings and constructions, equipment configuration, accomplishment of heating, illumination, ventilation are **technical actions**. So, on explosion and fire risk objects are subdivided into five classes depending on application or storage of materials and substances: A, B, C, G and E.

Class A - explosive risk productions at which combustible gases and volatile flammable liquids with flash point no more than 28°C in such quantity that substances and materials can form explosive vapour-, gas- and air-mixtures at which ignition explosion overpressure more than 5 kPa develops indoors, and also, substances and materials capable to burst and burn at interacting with water, air oxygen or with each other in such quantity at which explosion overpressure more than 5 kPa develops indoors are applied.

Class B- explosive risk productions at which combustible dusts or fibers, volatile flammable liquids with flash point more than 28°C in such quantity, that substances and materials can form explosive heat - and air-steam mixtures at which explosion overpressure more than 5 kPa develops indoors are applied.

Class C – fire risk productions at which combustible and difficaltcombustible liquids, solid combustible and difficaltcombustible substances and materials, capable only to burn at interacting with water, air oxygen or with each other are used.

Class G – fire risk productions at which incombustible substances and materials in incandescence, hot and molten state at which processing is followed by evolution of radiant heat, sparks and flame; combustible gases, liquids and solid materials which are burnt or utilized as a fuel are used.

Class E – fire risk productions at which nonflammable substances and materials in cold condition are used.

Fire-resistance - ability of buildings, constructions and building structures to retain their functions at fire. It is characterised *by fire-resistance limit* is the index of fire-resistance of a construction, defined by a time from the beginning of standard test fire to one of limiting conditions standardised for the construction on fire-resistance.

Construction condition, at which it loses ability to retain one of its fireproof functions, is called **as limiting condition of a construction on fire-resistance.** Following limiting conditions are standardized:

✓ *load-carrying capacity loss* (R) owing to breakdown of construction or origination of ultimate strains,

✓ *integrity loss* (E) as a result of formation in construction of through-the-thickness cracks or apertures through which on not warmed surface combustion products or flame are penetrated,

✓ *loss of thermo- insulating capacity* (I) owing to rise of temperature on not warmed surface of construction on the average on 140°C.

On fire risk building constructions are subdiveded into four classes which are defined by results of standard tests:

K_0 - not fire risk,

K_1 - little fire risk,

K_2 - moderate fire risk,

K_3 - fire risk.

Fire-resistance of buildings is characterized *by fire-resistance extent* - is the classification characteristic of object defined by indexes of fire-resistance and fire risk of building constructions.

Rationing of buildings and constructions on fire-resistance extents is necessary for maintenance of demands of system of fire protection regarding restriction of fire expansion out of fireplace and for maintenance of collective protection of people and stocks of materials and capital equipment at buildings and constructions. With that end in view buildings on functional purposes are subdivided into classes:

Class F1- buildings for constant and time residing,

Class F2 - spectacle and cultural-educational establishments,

Class F3 - organizations on population service,

Class F4 - educational institutions, scientific and design organizations,

Class F5 - industrial and storage buildings, constructions and premises (F 5.1 - production buildings and constructions, industrial and laboratory premises, workshops; F 5.2 - storage buildings and constructions, parking for cars without service and repair, book depositories, archives, warehouses; F 5.3 - agricultural buildings; F 5.4 - administrative and household buildings of factories).

Actions **of regime character** – is a set of measures and requirements of fire safety which are predetermined for object or separate premise and subjected to obligatory performance by all workers of this establishment. These are inhibition or localization of smoking places, measures on safety organization of welding and other hot-fire works, observance of **fireproof regime** - is a complex of fire fighting measures at performance of works and objects exploitation.

5. Protection immediately from a fire involves protection of workers against heat and dangerous toxic liquids evolved into air at fire. Thermo-insulating clothes of firemen, isolating gas-masks and apparatuses on the compressed air, hoods filtrating air as gas-masks are used for these purposes.

Any fire is the easier for liquidating in initial stage, taking appropriate measures for fire localization to prevent expansion of burning square. **Fire localization is** the acts referred on prevention of possibility of the further extension of burning and creation of conditions for its successful liquidation by available forces and means. **Fire liquidation is** the acts referred on definitive fire stopping, and also on exclusion of possibility of its repeated origination. Success of fast and effective fire localization and liquidation in its initial stage depends first of all on presence of proper means of fire extinguishing, fire connection and alarm for calling of fire aid and operatively use ability.

Principles of termination or entering depression in combustion zone of air and inflammables, cooling of combustion zone below self-ignition point or temperature decrease of burning substance below ignition point, and also diluting of reactants with nonflammable substances and insulation of inflammable from combustion zone are fire suppression principles.

Extinction of a fire may be achieved in a number of ways:

1. stopping the supply of fuel vapours;
2. quenching the flame by chemical extinguishers (inhibiting);
3. removing the supply of air (oxygen) to the fire (smothering);
4. "blow-out".

Fire extinguishing is a process of impact of forces and means, and also use of methods and ways for its liquidation. Fire extinguishing is added up to active mechanical, physical or chemical impact on combustion zone for instability by one of the taken means. Stability of burning depends first of all on temperature in chemical reaction area which is defined by conditions of thermo exchange with environment. Thus, thermo disequilibrium and temperature decrease in combustion zone at fire extinguishing can be attained ether increase of rate of warmth loss or decrease of rate of warmth excretion in combustion zone.

Correct choice of ways and means of fire extinguishing is the important component of effective fire extinguishing. Choice of ways and means of fire extinguishing depends on production technique and physical and chemical properties of applied raw materials, intermediates and products, the conditions expelling appearance of harmful side effects at interacting of fire extinguishing mean with burning substance, and also conditions of burning process and the technical possibilities used for fire extinguishing.

When selecting the appropriate type of fire extinguisher, it is important to think about extinguishing agents. Each class of fire is best fought by a specific

extinguishing agent. You will find a color-coded box on your fire extinguisher identifying which classes of fire it can be used for, and the type of fire extinguishing agent it contains.

The following is a list of commonly used fire extinguishing systems and their corresponding classes of fire. The classes are indicated in parentheses such as (A, B, C):

- **Multi-Purpose Dry Chemical (A, B, C)** - a dry chemical agent called mono ammonium phosphate. The chemical is non-conductive and can be mildly corrosive if moisture is present. In order to avoid corrosion, it is necessary to scrub and thoroughly cleanup the contacted area once the fire is out. A dry chemical fire extinguisher is usually used in schools, general offices, hospitals, homes, etc.
- **Regular Dry Chemical (B, C)** - a dry chemical agent called sodium bicarbonate. It is non-toxic, non-conductive and non-corrosive. It is easy to cleanup, requiring only vacuuming, sweeping or flushing with water. Extinguishers with sodium bicarbonate are usually used in residential kitchens, laboratories, garages, etc.
- **Carbon Dioxide (B, C)** - carbon dioxide removes oxygen to stop a fire but has limited range. It is environmentally friendly and leaves no residue, so cleanup is unnecessary. Extinguishers with carbon dioxide are usually used in contamination-sensitive places such as computer rooms, labs, food storage areas, processing plants, etc.
- **Halotron (A, B, C)** - a vaporizing liquid that is ozone friendly and leaves no residue. Because it requires no cleanup, fire extinguishers with halotron are ideal for computer rooms, telecommunication areas, theaters, etc.
- **Foam (A, B)** - foam floats on flammable liquids to tame the fire and helps prevent reflashes. To cleanup the affected area, it must be washed away and left to evaporate. Fire extinguishers with foam are usually used in garages, homes, vehicles, workshops, etc.
- **Purple K Dry Chemical (B, C)** - a dry chemical called potassium bicarbonate. It is non-conductive and non-corrosive. Clean up requires vacuuming, sweeping or flushing with water. Extinguishers with potassium bicarbonate are usually used in military facilities, oil companies, vehicles, etc.
- **Water (A)** - the most common agent is water; however, it cannot be used for class B or C fires because it is conductive. Water-based fire extinguishers are usually used in stockrooms, schools, offices, etc.

Table 1. Type of Extinguisher according to Fuel Source and Class of Fire

Fuel Source	Class of Fire	Type of Extinguisher (Extinguishing Agent)
Ordinary combustibles (e.g. trash, wood, paper, cloth)	A	Water; chemical foam; dry chemical*
Flammable liquids (e.g. oils, grease, tar, gasoline, paints, thinners)	B	Carbon dioxide (CO_2); halon**; dry chemical; aqueous film forming foam (AFFF)
Electricity (e.g. live electrical equipment)	C	CO_2; halon; dry chemical
Combustible metals (e.g. magnesium, titanium)	D	Dry powder (suitable for the specific combustible metal involved)

* Dry chemicals, CO_2 and halon can be used on Class A fires, but may not be effective on their own. They need to be supplemented with water.

** Halon extinguishers are no longer made but some may still be in use. Dangerous gases are formed when halon is used to put out fires. Wear proper respiratory equipment, particularly in enclosed spaces. After use, do not allow anyone to enter the area until it has been well ventilated.

At suppression of fires **means of fire extinguishing** are applied. These are substances possessing physical and chemical properties, allowing creating of conditions for fire stopping. Fire extinguishing substances can be in solid, liquid or gaseous state (water, other liquids, water vapours, gases, powders of some substances). At choice of substance for fire extinguishing it is necessary to consider its compatibility with burning material, i.e. to expel possibility of explosion origination, excretions of toxic, corrosive-active and other substances in fireplace.

Water is the most widespread fire-extinguishing means. It possesses three properties of fire extinguishing: cools combustion zone or burning substances, dilutes with reactants in combustion zone and isolates inflammables from combustion zone. Water is applied to suppression of solid combustible materials, creations of water curtains and cooling of objects, technological equipments, apparatuses, constructions, buildings, etc., situated near to fireplaces. Water cannot be applied to suppression of the equipments and plants, being energized, in connection with its high electrical conduction.

At suppression of water-insoluble easy oils and other inflammables with density less of water density they float and continue to burn on its surface. Thus area of burning surface is enlarged, that essentially can complicate fire extinguishing conditions.

For increase of penetration capability of water it is necessary to reduce its surface tension. Surface-active materials are added into water with that end in view. Their addition reduces water flow in 2,0-2,5 times and considerably reduces fire extinguishing time.

Fire-extinguishing foam is a system, in which gas is a dispersed phase always. At density of 0,1-0,2 g/sm^3 foam spreads on surface of burning liquid, cooling and isolating it from flame. Thus entering of combustible vapours in combustion zone is stopped and flame is died away. Resistant foam which can be received at addition of 3-4 % foam former in water and is capable to reduce surface tension of water film is applied to suppression of fires. On surface of burning liquids foam forms the proof film which is not destroyed under flame influence during 30 mines – is a sufficient time for suppression of inflammables and volatile flammable liquids in basins of any diameters.

Fire-extinguishing properties of foam are defined by its stability, repetition factor, biodegradation and wetting ability.

Foam stability - is its ability to conservation of initial properties.

Foam repetition factor – is the relation of foam volume to solution volume from which it is formed. Foams with larger repetition factor are less stable. Foam quality is defined by its dispersiveness in many cases. The higher dispersiveness the more foam stability and higher its fire-extinguishing efficiency. Two kinds of stable fire-extinguishing foams find wide application: *air-mechanical and chemical.* They are applied to suppression of solid materials, volatile flammable liquids with density less than 1 and not dissolving in water. Chemical foam, as a rule, is more stable than air-mechanical.

In case of possibility of explosion because of accumulation in burning premise of combustible gases or vapours it is necessary to form in it the medium which is not keeping combustion. It is attained by application **of inert dilutants** as fire-extinguishing means, such as

- ✓ water vapour,
- ✓ nitrogen,
- ✓ carbon dioxide,
- ✓ argon,
- ✓ smoke gases,
- ✓ some other substances.

Inert dilutants reduce reaction rate as the part of warmth of burning is spent for their heating.

Water vapour is used for creation of air-steam curtains on the open technological equipments, and also for fires suppression in premises of small volume and technologic equipment (dryers, reactors, columns, etc.).

Nitrogen is mainly applied at suppression of the substances, burning with flame. It badly extinguishes substances, capable to smoulder (wood, paper), and practically does not extinguish fibrous substances (cloth, cotton wool, cotton).

Carbon dioxide is applied to volume suppression of fires in warehouses of volatile flammable liquids, accumulator plants, in drying ovens, at stands for engine-test of electric equipments.

Halogen hydrocarbon compounds are fire extinguishers on the basis of hydrocarbons in which one or several atoms of hydrogen are substituted on atoms of halogens. They are inhibitory means suppression with which occurs as a result of slowdown of chemical reactions. They are applied to volume suppression, for superficial suppression of small fireplaces and for prevention of formation of explosive medium, used for protection of especially dangerous shops of chemical productions, dryers, spray cabinets, warehouses with combustible liquids. Halogen hydrocarbon compounds are not recommended to apply to suppression of metals, of some metallic compounds, hydrides of metals, and also the materials containing in the composition oxygen. Practically all these compounds are harmful for human body, are weak narcotic toxins, and products of their thermal decomposition possess high toxicity, and also are characterized by high corrosion.

Solid and combined fire extinguishers substances in the form of powders possess high fire-extinguishing efficiency. They are capable to suppress burning of various, including pyrophoric compounds and substances which are not giving in to suppression by water or foam. The suppression principle with powdered compositions encompasses either isolation of burning materials from air, or isolation of vapours and gases from combustion zone. Besides, powdered compositions are capable to inhibit flame at entering in fireplace. Powdered compositions are applied to suppression of metals and metal wares, organometallic compounds, pyrophoric substances, gas flame.

Powdered compositions possess such advantages as high fire-extinguishing efficiency, universality, possibility of suppression of fires of the electric equipment which are energized, and their uses at minus temperatures. They are non-toxic, do not cause corrosion action, do not put out of commission equipment, materials, they can be used in atomized water combination and foamy fire extinguishers.

6. Means of fire extinguishing can be divided in two big groups - primary fire extinguishing means and automatic stationary fire-extinguishing systems.

Primary fire extinguishing means are applied to suppression of small fireplaces. These are internal fire-cocks, fire extinguishers of various types, sand, felt, felted cloth, asbestos fiber. For placement of primary fire extinguishing means in industrial and other premises, and also in factory territory special fire posts or boards are established.

On fire boards only those primary fire extinguishing means are placed, which can be applied in the given premise, construction, equipment. Fire extinguishing means and fire posts are placed on visible places and coloured in suitable colours.

Internal fire-cock is an element of internal fire water supply system. Containers for water storage must have volume not less than 200 dm^3 and be completed with cover and bucket. Containers are coloured in red colour and inscribed in white colour «For fire extinguishing». Water is added not less often than once in 10 days into the basin, it is completely changed once in a quarter. Containers for sand must have volume 0,5, 1,0, 3,0 m^3 and to be completed with shovel. Sand must be examined once in 10 days and, at humidification or lumpiness detection, replaced. Linen, felted cloth must have 1, 1,2, 1,5 or 2 × 2 m sizes, they must be kept in metal or plastic cases with covers. Periodically, not rarer than once in a month, these materials are dried up and refined of dust.

Fire extinguishers are the technical devices intended for suppression of fires in initial stage of their origination.

Fig. 3 – Fire extinguisher

Fire extinguishers classification: on a sort of fire extinguishing means, case volume, way of fire extinguishing means feed, a sort of starting devices.

By case volume fire extinguishers are subdivided into:

- midget manual (to 5 dm^3),
- industrial manual (5-10 dm^3),
- stationary and mobile (more than 10 dm^3) extinguishers.

By way of fire extinguishing means feed fire extinguishers are subdivided into:

- extinguishers acting under pressure the gases formed as a result of chemical reaction (chemical foam),

- extinguishers acting under pressure of charge or working gas which is over fire extinguish substance (carbon-dioxide, aerosol, mechanical foam),
- extinguishers acting under pressure of working gas which is in separate balloons (mechanical foam, aerosol), with free discharge of fire extinguish substances (dry powder, type EP-1).

By a sort of starting devices fire extinguishers are subdivided into:

- extinguishers with barrier gated,
- extinguishers with shut-triggering arrangement of pistol type,
- extinguishers with start from exploder.

By a sort of fire extinguishing means fire extinguishers are subdivided depending on used means of suppression into:

- foam,
- gas,
- dry powder.

Foam extinguishers by a design are subdivided into:

- chemical,
- mechanical foam
- fluid for feed of air-mechanical foam.

ECF-10, EF-14, EF-9MM have the greatest application. They are used for suppression of fires of combustible solid materials, volatile flammable and combustible liquids. For fire extinguisher acting the handle is lifted upwards and the extinguisher is turned a cover downwards. Thus the valve of acid glass is opened. sulphuric acid is flowed out from the glass and is mixed with alkali. As a result of chemical reaction of sodium bicarbonate with sulphuric acid carbon dioxide is formed, pressure in the extinguisher case is sharply raised and foam is thrown out from the nozzle. Foam extinguishers are subjected to recharge once a year.

Gas extinguishers are subdivided into:

- ***carbon-dioxide*** (carbon dioxide in the form of gas or snow),
- ***aerosol,***
- ***carbon-dioxide-bromine-ethyl.***

In carbon-dioxide gas fire extinguishers carbon dioxide in the form of snow is formed at fast evaporation of carbon-dioxide liquid. This way is used at local suppression of ignitions and for oxygen content decrease in combustion zone. Carbon-dioxide gas fire extinguishers can be manual, stationary and mobile. For suppression of fires with manual carbon-dioxide extinguishers it is necessary to open the gate and to direct on burning object. Carbon-dioxide extinguishers are subjected to recharge once in five years, thus annually check on leakage of carbon

dioxide with notice in the check card must be made. At decrease of carbon-dioxide mass more than on 5 % the extinguisher is recharged.

For suppression of ignitions of volatile flammable liquids, solid materials, electrical installations which are energized and other materials, except for alkali metals and oxygen-containing substances, aerosol and carbon-dioxide-bromine-ethyl gas fire extinguishers are applied. Aerosol extinguishers EA-1, EA-3 must be in the vertical position at suppression. At work of the extinguisher access of gas from the extinguisher balloon in the extinguisher case is opened. Pressure in the case increases, and ethyl bromide enters through the siphon pipe into the exit nozzle in which charge fluid phase turns in liquid-gas aerosol jet. In carbon-dioxide-bromine-ethyl gas fire extinguishers ECD-3 and ECD-7 the charge consists of 97 % of ethyl bromide and 3 % of carbon dioxide, pressure is created by means of compressed air.

Dry powder extinguishers are applied routinely to suppression of ignitions of volatile flammable and combustible liquids, alkaline-earth metals, electrical installations which are energized. Dry powder extinguishers can be *portable* (EPU-2-01, EP-2M, EP-10 with recharge once a year, EPU -2-02, EP-10Ф, EP-5, EPU - 10 with recharge once in 2 years) and *mobile*. The maximum warranty period of gas generation elements storage in extinguishers is 4 years.

Inspect fire extinguishers at least once a month (more often in severe environments). Fire extinguisher maintenance is important for everyone's safety.

You must ensure that:

- The extinguisher is not blocked by equipment, coats or other objects that could interfere with access in an emergency.
- The pressure is at the recommended level. On extinguishers equipped with a gauge (such as that shown on the right), the needle should be in the green zone - not too high and not too low.
- The nozzle or other parts are not hindered in any way.
- The pin and tamper seal (if it has one) are intact.
- There are no dents, leaks, rust, chemical deposits and/or other signs of abuse/wear. Wipe off any corrosive chemicals, oil, gunk etc. that may have deposited on the extinguisher.

Some manufacturers recommend shaking your dry chemical extinguishers once a month to prevent the powder from settling/packing. Fire extinguishers should be pressure tested (a process called hydrostatic testing) after a number of years to ensure that the cylinder is safe to use. Consult your owner's manual, extinguisher label or the manufacturer to see when yours may need such testing. If the extinguisher is damaged or needs recharging, replace it immediately! Recharge all extinguishers immediately after use regardless of how much they were used.

Stationary fire extinguishing installations are stationary installed apparatuses, pipelines and equipment which are intended for extinguish substances feed in combustion zone.

Mobile installations in the form of pumps for water feed and others extinguish substances to a fireplace are installed on fire-engines. Fine-engine vehicles, tanks lorry, autopumps, engine driven pumps, fire trains, steam-ships are fire-engines.

The installations, in which all elements are installed and are constantly in readiness for action, are named **automatic stationary fire-extinguishing systems.** Buildings, constructions, production lines, groups or some technologic equipment are equipped with stationary installations. Fire extinguishing stationary **installations** have, as a rule, automatic local or remote engaging and simultaneously carry out function of automatic fire alarm.

Sprinkling installations are switched on automatically at temperature rise to the prescribed limit indoors. Sprinklers are detecting devices of such systems. Sprinkling installations have basic and auxiliary automatic water feeders. The automatic water feeder is elevated tank, hydropneumatic equipment, water supply system. It must submit water before switch connection of the basic water feeder - a pumping station.

Drenchering installations are analogous of sprinkling installations on the device. They are applied in premises with high fire risk. At burning of volatile flammable liquids these equipments localize fire and prevent fire expansion on the next premise. The pipeline system of these equipments is constantly filled by water up to drenchers. Drenchers are sprinkler heads without fusible locks.

Fire alarm is intended for fast notice about fire. The technological equipments of high fire risk, industrial and office buildings, warehouses are equipped with fire alarm installations. Fire alarm can be ***electric and automatic.***

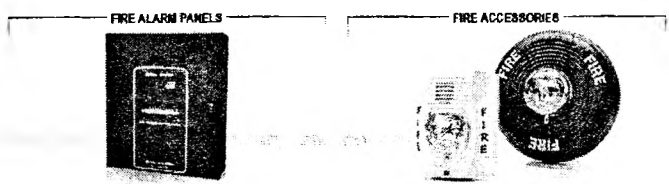

Fig. 4. Fire alarm system

Electric fire alarm depending on the connection scheme of informers to reception station can be *beam and loop, or ring*. At arrangement of beam fire alarm each informer is joined to reception station with two wires forming a separate ray.

At arrangement of manual informers loop system ordinary provides for switching on of approximately 50 informers consistently on one line. Manual fire alarms can be positioned both out of buildings on walls and constructions at height of 1,5 m from floor or land level and on distance of 150 m from each other, and in premises - in corridors, passages, stairwells, and as needed in closed premises on distance no more than 50 m. They are installed one on all stairwells of each floor. Place of manual fire alarms is lighted by artificial light.

Fig. 5. A fire alarm notification appliance with a strobe light

Automatic informers are sensing elements signaling about fire. They are subdivided into:

- heat,
- smoke,
- light,
- combined.

For instantaneous reception of an alert at the very beginning of ignition at appearance of flame, smoke fast-response informers with photoelectric cells, counters of photons, ionization chambers are applied now.

Fire connection and signaling system are of great importance for realization of actions on fires prevention, promote their timely detection and calling of fire-brigade to fireplace, and also provide management and operative job management at fire.

7. The ministry of extreme situations through regional managements and local organs presides management in the field of fire safety in the Republic of Belarus. All organizational, control and administrative functions of governing bodies are added up to:

- working out and coordination of fire protection regulations, rules, technical specifications for new constructions and redesigned objects of different function, and also fire prevention rules for existing objects;

- control of observance by design organizations of fire protection regulations, technical specifications and rules at design of new and redesign of existing objects, buildings and constructions; fireproof condition supervision of existing economic objects, residential constructions and public buildings and observance of due fire-proof regime at them;

- registration and analysis of fires reasons;

- propagation of fireproof prophylaxis;

- administrative work;

- inquest.

According to the Law of the Republic of Belarus «About fire safety» the duty of maintenance of fire safety at an object is imposed on heads, officials and each worker. Concrete duties of each worker are written in duty regulations. Director appoints the responsible officials for fire safety on each subdivision by his order.

Administration of an object or employer are obliged to provide full and timely performance of fire prevention rules and fireproof requirements of building standards at design, construction and maintenance of objects, to organize at the object fire protection, voluntary fire-brigade and fire-technical commission, to provide necessary means for the maintenance of fire protection, acquisition of fire extinguishing appliances. to prescribe the persons responsible for fire safety on each subdivision.

Technical and engineering employees responsible for fire safety at subdivision are obliged to know fire risk of technological processes, to carry out rules and requirements of fireproof regime at the object, to keep observance by workers and employees of these rules and requirements. For each production or object on the basis of standard fire prevention rules of the industrial factories fireproof instructions must be developed. All preventive work in the field of fire safety at an object is imposed on fire-technical commission. On the basis of the analysis of fireproof regime condition, revealing of technological violations and lacks fire-technical commission develops fireproof measures.

Each worker is obliged to know and fulfil requirements of fire safety, and also to observe and support fireproof regime, to know precautionary measures at work with volatile flammable and combustible liquids, other fire risk materials and equipment, the characteristic of fire risk of applied or made substances and materials, to inform fire prevention service in case of fire origination and to take possible measures for rescue of people, salvage and fire liquidation.

According to existing legislation for attraction of technical and engineering employees to participation in process on carrying out of fire preventive actions at objects **fire-technical commission** is organized. The management of commission is imposed on deputy administrator or chief engineer. Not less often than an once in half-year the commission makes detailed check of observance of rules and standards of fire safety and develops actions on elimination of revealed violations which are made out by the certificate confirmed by head of object and are subjected to accomplishment in the law day.

Voluntary fire-brigade is formed of number of workers, technical and engineering employees irrespective of presence of other fire services. Numerical strength of voluntary fire-brigade is defined by head on the basis of 5 persons on each 100 workers. At quantity of workers at a factory to 100 persons quantity of brigade must be not less than 10 persons. If quantity of workers at a factory is less than 15 persons brigade is not framed and fire duties are imposed on each worker.

Supervisory of observance of fireproof regime, carrying out of explanatory work among workers on observance of fireproof regime on work places and rules of cautious use of fire in private life, supervision of serviceability of fire extinguishing means and their availability, calling of fire service in case of fire origination, taking actions on its suppression by available means are the primary goals of voluntary fire-brigade. Members of voluntary fire-brigade take part in localization and liquidation of ignitions, evacuation of people and stocks of materials and capital equipment from burning premises.

8. The bases of fire safety observed in lecture are evidence of importance of the given part in labour safety of workers, including in organizations of public health services and educational institutions. The resulted data on theoretical bases of burning, fire and explosive materials, fire extinguisher means show that non-compliance with the requirements of fire safety at objects can be the reason of fire or explosion origination. It is the reason of influence workers of dangerous fire factors, health disorders and material damage.

It is necessary to emphasize that the studied materials on prevention and liquidation of fires, organization of fire protection at objects allow to prevent fire and at the same time injury and death of workers, and also to provide protection of stocks of materials and capital equipment.

For fire prevention at objects the Law of the Republic of Belarus «About fire safety» and also complex of organizational, operational, technical and regime actions are of great importance.

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