UKRAINIAN MINISTRY OF HEALTH
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Approved
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Procedural Instructions
FOR UNSUPERVISED STUDENT WORK WHEN PREPARING FOR A PRACTICAL LESSON

Academic discipline	Occupational health and safety for healthcare workers
Module No. 1	Occupational health and safety for healthcare workers
Content module No. 2	Introduction to workplace safety for healthcare workers
Lesson topic	Fundamentals of Healthcare Worker Occupational Safety
Year	V-VI
Faculty	Medical No. 1-4, Ukrainian Armed Forces Physician Training Faculty (UARPTF), dental.

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1. Timeliness of the topic:

Electric power is widely used in all sectors of the economy, in transportation, in everyday life, and in medicine. Man has harnessed electric power. But in addition to the benefits that electricity creates, it is a source of extreme danger. In order to understand the reasons for this, it is necessary to know the nature of electricity and its effect on the human body.

An electric hazard is often associated with fires. A ***fire*** is an uncontrolled combustion process that is accompanied by the destruction of tangible assets, and that poses a threat to the life of patients and medical personnel. Over the past 8 years, the causes of the fires that most often resulted in human fatalities have been: the hazardous handling of flames – 65% of the total number of deceased, and the violation of electrical appliance (including medical instrument) installation and operating rules – 17%. More than a third of the cases of human death occur at nighttime – from 10:00 p.m. till 6:00 a.m. This is often recorded at hospitals for mental patients and the elderly.

Collateral damage due to fires has been tracked in the Ukraine since 1998. Over this period time, the daily economic losses came to 680,000 hryvnias (UAH).

A large complement of legislative acts, orders, regulations, and instructions has been established in our country concerning current and fire protection. Therefore, the nature of electricity, combustion processes, their effect on the body, and means for preventing their negative impact has recently begun to take on special importance.

2. Specific goals:

1. To classify and distinguish the following types of negative impacts on the human body: biological, thermal, electrochemical, and mechanical.
2. To be aware of the factors that influence the consequences of electric trauma.
3. To be familiar with electrical safety features and safety arrangements during the use of electrical appliances.
4. To be able to render first aid during electric trauma and during a fire.
5. To be aware of the reasons for the occurrence of fires, safety measures, and general fire safety requirements.

3. Basic knowledge, abilities, and skills needed in order to study the topic (interdisciplinary integration).

Names of previous disciplines	Skills acquired

1. Human Anatomy	To analyze information on the organization of the human body, as well as the systems, organs, and tissues that that comprise it. To identify the topographic-anatomical relationships of human organs and systems.
2. Medical and Biological Physics	To explain the physical principles and biophysical mechanisms of the influence of external factors on human body systems. To evaluate the general physical and biophysical regularities that form the basis of human vital activities.
3. Medical Chemistry	To interpret types of chemical equilibrium in order to formulate an integral physicochemical approach to the study of the body's vital processes. To use chemical quantitative and qualitative analysis techniques. To classify the chemical properties and transformations of bioinorganic substances over the course of human vital activities. To evaluate the general physicochemical regularities that form the basis of human vital activities.
4. Microbiology, Virology, and Immunology	To interpret the biological properties of pathogenic and nonpathogenic microorganisms and viruses, as well as the regularities of their interaction with macroorganisms, the human population, and the external environment.
5. Normal Physiology	To analyze the state of human health under different conditions based on physiological criteria.
6. Biological Chemistry	To interpret the importance of biochemical metabolic processes and their regulation in ensuring the functioning of organs, systems, and the human body as a whole.
7. General Hygiene and Human Ecology	To analyze the status of the environment and the effect of its factors on the health of different segments of the populace.

	To interpret the basic laws of health science, as well as the general regularities of the interrelationship of health with vital environmental factors and conditions.

4. Assignments for unsupervised work when preparing for the lesson.

4.1. List of basic terms, parameters, and characteristics that a student must master when preparing for the lesson:

Term	Definition
Electric trauma	Damage caused by the influence of an electric current (electric burns, electric marks, and mechanical damage)
Electrical safety	A set of measures and means that ensure human protection against the harmful influence of an electric current
Human body resistance	Is determined by skin resistance to an electric current
Insulation	Equipment current-conducting component protection that ensures normal hardware operation
Fire	Uncontrolled combustion that spreads in time and space, and that poses a threat to human life
Fire safety	A facility status during which the possibility of the occurrence of a fire and human exposure to its hazardous factors is precluded with a regulated probability
Fire alarm	An appliance for detecting the initial stage of a fire, transmitting messages, and activating automatic firefighting system if necessary

4.2. Theoretical questions for the lesson:

1. Effects of an electric current on the human body.
2. Classification of general electric traumas.
3. Factors that influence the consequences of electric trauma.
4. Causes of death due to an electric current.

5. Electrical safety features.

6. Safety arrangements during the use of electrical appliances. Techniques for rendering first aid during electric trauma.

7. State Fire Supervision Service. Design and operation of prevention-and-treatment facilities (PTFs) and medical equipment.

8. Explosion and fire hazard property indices of materials and substances. Explosion and fire hazard ratings of interior spaces.

9. Basic means and measures for the assurance of medical facility fire safety. Fire Alarms. Firefighting equipment.

10. Personnel actions during firefighting. Personnel evacuation. Fire safety status monitoring. PTF worker training in fire safety rules.

4.3. Practical work (assignments) to be completed during the lesson:

1. Familiarize yourself with the procedural instructions for the topic and record the definitions of paragraph 4.1 in the workbook.

Solve the following situational problems:

Problem 1

During the stage of the state expert review of a category V pharmacy site design for a rural location, the State Fire Supervision Service inspector obtained the following information:

• tract of land – separate;

• area of the tract of land – 0.02 hectares (ha);

• on the grounds, the allocation of the following is envisioned: for construction – 45%, for landscaping – 45%;

• vehicle entrance – one to the service facilities;

• entrance to the main building – through the service area;

• the following are planned for the site – a main building and a garage.

What approval option should be anticipated and why?

Problem 2

When taking a fire safety qualification class and asked what the main duties of a supervisor are in the area of fire safety, the pharmacy manager named the following:

• organizing worker training on fire safety matters, and;

• conducting official investigations of instances of fires.

Is this answer complete? If not, then offer your addenda.

Problem 3

A fire supervision service inspection office check of a district pharmacy revealed that:

• the distance from the pharmacy warehouse to the pharmacy garages is 6 meters (m);

• the fire ladders are stored in the attic of a 2-story pharmacy facility;

• the fire extinguishers are kept in the supply manager's storeroom, and;

• the driveways to the pharmacy facilities have a width of 1.6 m.

What should the Compliance Orders and requirements be expected to contain?

Problem 4

A State Fire Supervision Service inspector checked the fire safety status of an interpharmacy drug and medical product depot, during which the following information was entered in the Compliance Order:

• a freestanding single-story facility;

• the interior spaces for drug storage have a area of 26 square meters (m^2);

• the staff room has an area of 6 m^2 and is separated from the storage area by a metal screen;

• highly flammable liquids are stored outside and the containers are painted black, and;

• the glass bottles in which highly flammable substances are stored do not have baskets and are arranged with 15 units in each group.

Did the inspector have grounds for entering this information in the Compliance Order? What corrections are needed?

Topic content:

Electrical Safety

Effects of an electric current on the human body

The following types of electric current influences on the human body are discerned: biological, thermal, electrochemical, and mechanical.

• The biological effects of a current are manifested by way of the aggravation and irritation of human flesh, as well as the disruption of the internal bioelectric processes that occur within the body and that are directly linked to its vital functions. This may be accompanied by involuntary, convulsive contractions of the muscles, including the heart muscles and the lungs. In this instance, blood circulation and respiratory organ performance are impaired or cease altogether.

• The thermal (heat-related) influence of a current results in burns to individual areas of the body, as well as the heating of the blood vessels, nerves, heart, brain, and other organs through which the current passes. This can cause significant functional disorders.

• The electrochemical (electrolytic) influence of a current causes the breakdown of organic fluids, including the blood, which is accompanied by considerable changes in their physicochemical composition.

• The mechanical effects of a current consist of separation, laceration, and other mechanical damage to the body's tissues, in particular – muscle tissue, blood vessel walls, and the vessels of the lungs due to an electrodynamic effect, as well as instantaneous explosive vapor formation as the result of a current's heat-related influence.

The cited types of an electric current influences can lead to adverse consequences, which is to say electric traumas.

Electric trauma is the damage caused by exposure to an electric current.

Electric traumas are divided into two types: local and general.

Local traumas originate when local damage to the body occurs. Local electric traumas include:

• electric burns;

• electric marks, and;

• mechanical damage.

An electric burn is the most widespread electric trauma, which occurs as a result of heat release when an electric current passes through different parts of the body.

Electric marks (tags) are well-defined spots, grey or pale grey in color, on the surface of human skin that has undergone exposure to a current.

Mechanical damage is a consequence of different muscle convulsive reflex contractions under the influence of a current that passes though the body. As a result, ligament, skin, and blood vessels ruptures may form, in addition to which joint dislocations and even bone breaks can occur.

General traumas, or so-called electric shocks, occur when the entire body is damaged (or a threat of damage is created) due to the disruption of the normal activities of vital organs and systems.

Classification of general electric traumas

Electric shocks can be divided into the following five levels as a function of damage consequences:

- barely perceptible muscle convulsive contraction;
- muscle convulsive contraction accompanied by severe pains, but without loss of consciousness;
- muscle convulsive contraction with loss of consciousness, but with the retention of respiration and cardiac performance;
- loss of consciousness and the disruption of cardiac activity or respiration, and;
- clinical death.

Electric shocks are responsible for more than 85% of fatal human injuries caused by an electric current in particular.

Fundamentals of safety arrangements

Factors affecting the consequences of electric trauma

The human body is a conductor of electric current, but the electroconductivity of biological tissue differs from the conductivity of metals, electrolytes, and gases. This is due not only to the physical properties of human flesh, but also to extremely complex biochemical and biophysical processes, as well as the properties of a biological substance.

When an electric current passes through it, the human body becomes an additional arm of an electric network. At the same time, the human body can also be relegated to the group of unique biopolymers, the conductivity of which can be equated to that of semiconductors.

Investigations of the nature of the electroconductivity of human flesh are ongoing in different countries, and the underlying mechanisms of the effects of an electric current are being studied.

Electrical safety consists of a set of measures and appliances that protect people against harmful exposure to an electric current.

Factors upon which the severity of electric trauma are dependent:

- current voltage intensity and magnitude;
- the electrical resistance of the human body and the duration of a current's passage through it;
- the nature of a current (alternating or direct);
- an individual's personal characteristics and environmental conditions, and;
- the path of an electric current's passage through the human body.

Factors that influence the consequences of electric trauma

The danger of injury to the human body by an electric current is dependent upon many factors, foremost among which are the following:

- the magnitude of the current passing through the human body;
- the electrical resistance of the human body;
- the duration of current exposure;
- current type and frequency;
- the path that a current takes, and;
- the individual features of the human body (body condition, age, and sex).

Man can physiologically perceive an electric current with an intensity as low as 1 milliampere (mA). An alternating power current with an intensity of more than 15 mA and a direct current with an intensity of 60 mA or more can cause respiratory and motion paralysis (a person is unable to disengage himself or herself from the current source). The danger of injury rises with an increase in current magnitude.

A variable-intensity current has different effects on man. The following current threshold values are highlighted:

- 0.6-1.5 mA (alternating current) and 5-7 mA (direct current) – the perceptible threshold current;
- 10-15 mA (alternating current) and 50-80 mA (direct current) – the freezing threshold current, which causes overwhelming muscle convulsive contractions of the hand in which a conductor is held as the current passes through the human body, and;
- more than 100 mA at a frequency of 50 hertz (Hz) (alternating current) and more than 300 mA (direct current) – the lethal fibrillation current.

The consequence of an injury is dependent upon the duration of a current's passage through the human body. This danger rises with an increase in the time that a person remains under voltage. The permissible safe current magnitudes as a function of the duration of exposure are:

- 6 mA during an exposure of up to 30 seconds;
- 75 mA during an exposure of up to 0.7 seconds (sec);
- 65 mA during an exposure of up to 1 second;
- 100 mA during an exposure of up to 0.5 sec, and;
- 250 mA during an exposure of up to 0.2 seconds.

Current type and frequency appreciably affect injury severity. A direct current has thermal and electrolytic effects, while an alternating current has biological effects, which is to say convulsions of the muscles, vessels, and vocal cords. An alternating current with a voltage of 500 volts (V) is more dangerous than a direct current with a voltage of 1,500 V. The danger of a direct current increases when the voltage rises above 500 V.

An alternating power current with a frequency of 40-50 Hz is more dangerous, while a high-frequency current of 500 kilohertz (kHz) or higher is less dangerous.

The role of the current passage path is extremely great and determines trauma severity. The following current passage paths exist: “hand-to-hand”, “hand-to-foot”, “foot-to-foot”, “right hand-to-left foot”, and “left hand-to-right foot”. A current that traverses the “hand-to-hand” and “hand-to-foot” paths encompasses a large number of nerve trunk sheaths, and this is the path through the hearts and lungs, which is regarded as the most dangerous one. Thus, the danger of injury is especially great when a current passes through the vital organs – the heart, lungs, and brain, and directly affects these organs. If a current does not pass through the subject organs, it only has a reflex influence on them and the probability of an injury is low. In most cases, a current link through the human body originates over the “right hand-to-foot” path. However, incapacitation for more than three workdays results from current passage over the “hand-to-hand” path – 40%, the “right hand-to-foot” path – 20%, and the “left hand-to-foot” path – 17%. The other paths are encountered less often.

An individual’s personal characteristics, as well as his or her physical and psychophysiological condition, have a considerable effect on electric trauma consequences. For example, a freezing current may be a threshold releasing current for some people and a freezing current for others. The nature of the effects of a current of the same magnitude is dependent upon a person’s weight and his or her physical development. It has been learned that the current threshold values for women are roughly 1.5 times lower than for men.

The extent of a current’s influence is dependent upon the state of the nervous system and the body as a whole. In this vein, in a state of nervous system excitation or depression, in a state of illness (especially during cardiovascular system, skin, nerve, and lung diseases), and in a state of inebriation, people are more sensitive to a current passing through them and experience serious injuries more often than healthy people.

The attention factor is also one of considerable importance. If a person is prepared for an electric shock, the extent of the danger is then dramatically reduced, whereas an unexpected shock leads to more serious damage.

Physicochemical, biochemical, and biophysical phenomena are responsible for human body tissue conductivity. For this reason, the human body’s resistance to an electric current is a nonlinear and unstable variable. The human body is an excellent conductor of electricity. A current flows through the human body along the path of least resistance, which does not always coincide with the shortest geometric path for it. This is explained by the appreciable difference in the specific resistances of different human body parts. The intensity of a current, I_i, that passes

through a human body is dependent upon the voltage, U_h, and resistance, R_h, of the human body, which is roughly considered to be active. It is thought that the resistance of the human body consists of skin resistance at the points of contact and internal tissue resistance. Resistance to an electric current is active-capacitive in nature. The capacitive component of skin resistance falls within limits of a few hundred picofarads to several microfarads.

Skin resistance determines human body electric current resistance. The skin, especially the uppermost horny layer that consists of dead keratinized cells devoid of blood vessels and nerves, has great specific resistance. Electrical resistance is the resistance of the current passing through an area of the body between two electrodes applied to the human body surface. That is to say, the resistance of the human body is nonlinear and varies as the voltage applied changes.

The magnitude of human body resistance is dependent upon the following factors:

- the condition of the horny skin layer;
- the presence of moisture and contaminants on its surface;
- the electrode application location;
- the current frequency, and;
- the duration of its effects.

Resistance magnitude is also dependent upon surface resistance and contact density from epidermis thickness. Human body resistance in the presence of dry, clean, undamaged skin, measured at a voltage of 15-20 V, fluctuates over limits of 3,000 to 100,000 ohms. Since the resistance of the human body to an electric current is nonlinear and unstable, and it is difficult to perform resistance calculations, human body resistance is then tentatively considered to equal 1,000 ohms with an accuracy that is sufficient for practice.

Body resistance drops as current frequency rises. A ten-fold human body resistance decrease occurs with an increase in voltage. For instance, elevated humidity creates current-conducting bridges in individual skin areas on the hands, thereby increasing its conductivity and heightening the danger of current injury. The soiling of the hands by scale and coal dust reduces human body resistance. Wood dust on carpenter's hands is less dangerous and the carpenter may have a higher resistance to a current. The soles and calloused palms have a resistance that is 20-50 times greater than that of the wrists.

Causes of death due to an electric current

The causes of death due to an eclectic current are: heart failure, respiratory standstill, and electric shock.

Heart failure is a result of the heart muscle's direct exposure to a current. Cardiac arrest and heart fibrillation set in. Under the influence of a current, the

heart stops working as a pump, the heart muscle fibers (fibrils) chaotically and rapidly contract, heart muscle convulsions begin, and the heart stops as a result of this. The heart does not ensure the movement of blood through the vessels and the body, left without oxygen-saturated blood, dies.

The direct exposure of the chest cavity muscles that participate in the respiration process to a current causes respiratory standstill. Shortness of breath (asphyxia) – a condition of oxygen deficiency and a shortage of carbon dioxide in the human body – occurs in 2-3 minutes.

A person gradually loses consciousness and reflexes, the heart stops, and clinical death ensues.

As previously stated above, electric shock is a unique serious neuroreflex reaction of the human body to strong stimulation by an electric current. Electroshock is accompanied by the profound disturbance of blood circulation, respiration, and metabolism with a duration of 0.1 seconds to 24 hours or more.

Electrical safety features

Electrical safety features encompass: the insulation of current-conducting parts, protective grounding, neutral grounding, safety shutdown, low voltage, potential equalization, electrical separation, protective devices, safety alarms, interlocks, safety signs, personal protection equipment, etc.

Insulation consists of protecting the equipment current-conducting components that ensure normal operation and guarding against electric trauma.

Under normal operating conditions, network insulation should be checked no less often than once a year. The resistance of power and lighting lead wires must be no lower than 0.5 megohms (MΩ).

Protective grounding consists of the electrical connection of the metal noncurrent-conducting parts of electrical equipment that might end up under voltage to a grounding device.

Pursuant to the Electrical Equipment Installation Rules (*PUE*), protective grounding is performed in the presence of an alternating current voltage of 390 V or higher and a direct current voltage of 500 V or higher. In interior spaces with a heightened danger, grounding is performed in the presence of an alternating current voltage greater than 36 V and a direct current voltage greater than 110 V.

Grounding device resistance must be no lower than 4 ohms. It is checked once every three years. Each grounding device must have a rating plate.

Nonconducting means of protection (gloves, tools with insulated handles, and mats) are checked once a year.

The personnel who service electric installations must be physically healthy, with no abnormalities, undergo a medical examination once a year, as well as annual certification, and have a group four electrical safety qualification rating.

Electric wiring insulation resistance is checked once every three years and must be greater than 0.5 MΩ.

Electric installations in medical facilities are equipped and operated:

• according to the unified "Electrical Equipment Installation Rules" – *PUE*;

• the "Electric Installation Operating and Maintenance Rules" – *PTE*, and;

• the Safety Rules During Electric Installation Operation – *PTB*.

Interior spaces are divided into the following as a function of the electric hazard level:

- those with heightened danger;
- especially dangerous ones, and;
- those with satisfactory safety.

Interior spaces with a heightened danger include those in which at least one of the following characteristics is present:

• an elevated relative air humidity – up to 75-100%;

• a high temperature – more than 35ºC;

• an electrically conductive floor;

• electrically conductive dust;

• component grounding, or;

• a chemically corrosive environment.

Interior spaces are especially dangerous when not less than two characteristics of interior spaces with a heightened danger are present, as well as: a high air humidity – approximately 100%, and a chemically corrosive environment. An interior space with satisfactory safety is one in which there are no hazard factors that exceed those cited.

Electrical equipment protection is accomplished by means of: connection to the power grid using fusible links (fuses) and automatic circuit breakers, and;

the metal housings of machine tools and electrical equipment on which human electric trauma is possible due to insulation failure are subject to grounding. The proper management of electric installation servicing consists of preparing a list of organizational and engineering measures:

- A computer tower must be connected to the current network using a special outlet that has a grounding contact and that is connected to the ground. Printers, scanners, and other peripheral devices are also subject to grounding. The equipment should be placed a distance of not less than 1 m from heating units in such a manner that it does not undergo exposure to direct sunlight, and;

- Pursuant to *PTE* and *PTB* documents, the following requirements are imposed on consumers and electric installation operating personnel:

a) individuals who have not reached 18 years of age and who exhibit signs of a departure from a healthy condition must not be permitted to work with electric installations, including those that are located in physical therapy rooms, and;

b) following theoretical and practical training, authorized individuals must sit for a test and have the appropriate certificate.

Safety arrangements when using electrical appliances and rendering first aid in the event of electric trauma.

When using electrical appliances, it is necessary to adhere to a number of precautionary measures:

• Before turning on an electric device, the cord must be visually checked for the presence of mechanical damage.

• Electrical appliances must be reliably grounded according to the appliance installation rules.

• It id prohibited to work with electrical appliances when the hands are wet.

• It id not be possible to leave an electrical appliance unattended for an extended period of time and an appliance mudy be checked at the end of work to ensure that it is off.

• When a malfunction is detected or occurs in an electric tool, the electrician who services the tool must immediately be summoned.

• It is categorically prohibited to independently perform any repair work.

In many instances, saving the life of a person injured by a current is dependent upon the swift and correct actions of the persons who render assistance. A victim must first be freed from exposure to the electric current as soon as possible. If it is not possible to disconnect the electrical equipment from the grid, steps must immediately be taken to free the victim from current-conducting parts without touching the victim in this instance.

First-aid measures after a victim is freed are dependent upon his or her condition. First aid must be immediately rendered at the incident location insofar as possible, while simultaneously calling for medical assistance. If the victim has not lost consciousness, he or she must be provided with a certain rest period that does not permit him or her to move until the physician arrives. If the victim is breathing infrequently or convulsively, but a heartbeat can be heard, cardiopulmonary resuscitation must immediately be performed on him or her. In the event of respiratory standstill, pupillary dilation, and cyanosis of the skin, cardiopulmonary resuscitation and external heart massage must be performed.

It is necessary to render assistance before the doctor arrives, since many cases exist when cardiopulmonary resuscitation and external heart massage returned a victim to life.

Fire Safety

Causes of the occurrence of fires at work and safety measures

Fire safety assurance is an integral part of government activities in the area of protecting human life and health, national wealth, and the environment.

A fire is uncontrolled combustion outside a special chamber that spreads in time and space, poses a threat to human life and health, and leads to material damage. Approximately 60,000 fires occur in the Ukraine each year, during which more than 5,000 persons die or sustain trauma.

The causes of the occurrence of fires on the job (based on statistical data) are:

- the careless handling of flames;
- equipment failure and the violation of equipment operating rules;
- equipment failure and process breakdown;
- process disturbances, and;
- the failure to satisfy the requirements of regulatory documents on fire safety matters.

The principal regulatory document that governs first safety requirements is the Ukrainian Law "On Fire Safety", adopted by the Ukrainian Supreme Council on December 17, 1993. This law defines the general legal, economic, and social principles of fire safety assurance within the Ukraine, and governs the relations of government authorities, legal entities, and physical entities in this area, regardless of their types of activities and forms of ownership.

According to the Ukrainian Law "On Fire Safety", responsibility for the fire safety of enterprises and institutions is entrusted to employers or their authorized representatives. Article 5 of the Ukrainian Law "On Fire Safety" stipulates the duties of employers or their authorized representatives, as well lessees, in the area of fire safety assurance. According to this law, they shall be obligated to:

- formulate a set of fire safety assurance measures;
- to formulate and approve the regulations, instructions, and other regulatory acts in effect within an enterprise pursuant to the regulatory acts governing fire safety, and to monitor their implementation, and;
- to organize the training of fire safety workers.

Safety Fundamentals

- maintain fire safety and communications equipment, fire-fighting equipment and inventory in good repair and do not misuse it;

- make official investigations in the event of fires.

All businesses must teach all employees the fire safety regulations and actions in the case of the outbreak of a fire. Persons who have not undergone fire

safety instruction are not allowed at work. Each employee is obligated to fulfill these requirements and also to take measures in the elimination of violations of the fire safety regulations and in fire suppression.

In accordance with article 6 of the law "On Fire Safety", Ukrainian citizens are obligated:

• to implement the fire safety regulations, provide buildings belonging to them as personal property with the primary means for extinguishing fires and firefighting equipment, and to educate children to be cautious around fire;

• to report to the fire department the outbreak of a fire and to take measures for putting it out and rescuing people and property.

Voluntary fire teams are created for the purpose of fire prevention and putting fires out at businesses. Fines are administered to responsible persons for the violation of the fire safety requirements.

Fire safety is a status in which the possibility of the origin and development of a fire and the impact of its dangers on people is eliminated with restricted probability, and the protection of valuables also is assured.

General Fire Safety Requirements

• Each employee must know the location of the primary means for extinguishing fires and know how to use them and employees must know the dos and don'ts during a fire and the emergency exits.

• Highly inflammable liquids and fuels may be stored in special separate locations, within the limits of the necessity and in accordance with the rules.

• Lubrication materials, highly inflammable liquids and fuels must be stored in special containers away from other materials and substances.

• It is forbidden to scatter flammable materials about. They must be removed from the facility after use to a specially allotted location. Do not cram them into basements or attics.

5. In case a fire breaks out, employees must immediately report it to the fire department by dialing 01 and to management, and begin to extinguish the fire by all available means.

The Dos and Don'ts and Safety Measures Upon the Break Out of a Fire

When a person is near a fire, he can come under the influence of such dangers and hazards as:

a) the fundamental fire hazards:

• toxic products of combustion;

• the fire;

• increased ambient temperature;

• smoke, insufficient oxygen;

b) secondary manifestations of fire hazards:

• destruction of building structures and explosions;

• leakage of dangerous substances occurring as a result of a fire;

• panic.

Toxic products of combustion represent the greatest threat for human life, especially during a fire in buildings (synthetic materials are the main source of toxic products of combustion). A high content of carbon monoxide is noted in the air most often. Carbon monoxide is a poisonous gas and inhalation of air in which its content is 0.4% is deadly.

The blaze is an extremely dangerous fire hazard. During a fire, the temperature of the flames can reach 1,200-1,400 degrees Celsius, and the flame's radiation can cause burns and pain in people located in the area of the fire.

The danger of an increase of the ambient temperature consists of the fact that inhalation of the heated air together with the products of combustion can result in lesions of the respiratory organs and death. An increase of the ambient temperature to 600 degrees Celsius in fire conditions is vitally dangerous for a human.

Smoke consists of a large quantity of small particles of unburned substances which have accumulated in the air. They cause intense irritation of the respiratory organs and mucous membranes (bad cough, watery eyes). Moreover, in a smoky facility evacuation of people is slowed as a result of the worsening visibility and the time to accomplish it is quite impossible.

Insufficient oxygen is caused by the fact that oxidation of the combustibles and materials occurs during the burning. A situation where the content of the oxygen in the air is lowered to 14% (normal is 21%) is considered dangerous for human life.

Destruction of building structures occurs as a result of the loss of their load-bearing capacity under the influence of high temperatures and explosions. At the same time, people can receive significant mechanical injuries caused by the debris of the collapsed structures.

Explosions and the leakage of hazardous substances can be provoked by their heating in a fire and the loss of pressure of containers or piping with hazardous liquids and gasses. Explosions increase the area of the combustion and can be the reason for the formation of new seats of fire. People in the vicinity may fall under the blast effect and be injured by the debris.

Panic is mainly provoked by rapid changes in the psychological condition of a person who is easily stressed in extreme situations. A majority of people fall into complex and uncommon conditions for the first time and do not have the corresponding psychological stability and enough training about it. When the effect of the fire hazards exceeds the limits of the psychological and physiological capabilities of a person, he can succumb to panic. Therein, he loses his common sense and his actions become uncontrollable and inadequate for the situation that has arisen. This phenomenon can lead to a massive loss of life.

The main danger from which people die in a fire is smoke and the hot air; therefore, it is necessary to breathe only through a wet cloth in a smoky facility. One must crawl on all fours in a smoky facility since there is less smoke lower down. On leaving a facility where a fire has started, the door must be tightly closed so the flame is deprived of oxygen. If there is smoke at the entrance (corridor), one must find out what has happened and then abandon the facility as quickly as possible through the main or emergency exit. It is possible to descend from the second and third floor on sheets or cables tied together if there is hazard to life.

In case of the discovery of a fire (signs of combustion), each medical employee is obligated:

• to report immediately about it by telephone to the fire department. At the same time one must give the address of the location, indicate the number of floors

in the building, the location the fire started, the situation in the fire, the presence of people and also report one's own name;

• to take (when possible) measures for the evacuation of patients and the fighting (localization) of the fire and the safekeeping of valuables.

Primary Means of Fighting Fire and the Rules for Using Them

Water is the basic method of impacting burning which is achieved by cooling. The seat of the fire is isolated during transformation into steam and the content of the oxygen decreases in the area of the fire. Water must not be used to extinguish highly inflammable substances (gasoline, kerosene), carbides, niter, and live electrical equipment.

Sand and blankets isolate the seat of a fire and lower the oxygen content in the area of the combustion.

The most important role among the primary means of fighting fires is set aside for the most effective of them – the fire extinguisher. It has been established that using fire extinguishers is most often successful in eliminating a fire in the first 4 minutes from the moment of its outbreak, that is, before the arrival of firefighting units.

Fire extinguishers are classified as water, chemical foam, carbon dioxide and powder.

Water fire extinguishers; pure water or water with special additives is the firefighting substance in them. The main influence on the fire is its cooling of the seat of the fire.

Chemical foam fire extinguishers (OHP-IO). The main influence on the fire is the isolation of the seat of the fire; an additional action is cooling owing to available water. One must keep in mind that foam conducts electricity, one must not put out live electrical equipment with it, it will damage all of the equipment.

Carbon dioxide fire extinguishers (OU, OU-3, OU-5). It uses colorless carbon dioxide without an odor and taste at a temperature of minus 70 degrees Celsius. The main influence on the fire is the thinning of the mix of the combustible vapors and gases with the air (oxygen), and in addition cooling (solid carbon dioxide). It is possible to put out live electrical equipment and also burning

liquids and solid substances. Spirits and acetone that dissolve carbon dioxide cannot be put out, the same goes for Thermite, photo film and celluloid, which burn without access to air.

Powder fire extinguishers (OP) – "Moment." The firefighting substances are ground mineral salts with various additives. Primary influence on the fire is inhibition. One can extinguish fires of any type, including live electrical equipment.

Four classes of fire have been established and also their symbols:

Class A – the burning of solids, chiefly organic in origin, which is accompanied by smoldering (wood, textiles, paper);

Class V – the burning of liquids or solids that melt;

Class S – the burning of gaseous substances;

Class B – the burning of metals and their alloys.

In addition to these four classes, an additional fifth class (E) has been introduced in Ukraine by the fire safety regulations adopted for the designation of fires connected with electrical power plants.

Cited below are the symbols of the classes of fires:

Figure 1. Symbols of the classes of fires

Symbols of the classes of fire are indicated on fire extinguisher bodies.

The choice of the type and the determination of the necessary quantity of fire extinguishers for protection of a facility is accomplished according to the existing Typical Standards for Ownership of Fire Extinguishers and industry regulations for fire safety.

Polyclinics and hospitals at each level must have not fewer than two portable (powder, watering or water) fire extinguishers with a charge weight of fire suppressant of 5 kilograms and greater.

Moreover, they must provide for one each carbon dioxide fire extinguisher with a charge capacity of fire suppressant of 3 kilograms and greater:

• for a 20 square meter floor in such facilities: offices with computers, closets, electrical panels, ventilation chambers and other engineering and utility services;

• for a 50 meter floor area of archives, libraries and museums.

The usage of fire extinguishers without the assignment of a person responsible for fire safety at the facility is not allowed.

The person responsible for fire safety at a facility must undergo special training according to the training programs agreed to by Ukraine's Ministry of Emergency Situations State Department of Fire Safety and receive the standard form of certification after passing an examination. A test of the person's knowledge who is responsible for fire safety at the facility is given once every three years by a certified training establishment.

The person responsible for fire safety at the facility is obligated to provide:

• requirements of the Regulations for the Use of Fire Extinguishers;

• the content of fire extinguishers in operating condition by means of his own timely inspection and maintenance of them;

• control of the systematic maintenance of the operating documents;

• training of the business's employees in the regulations for the intended use of the fire extinguishers.

To assure the operable condition and high quality usage of the fire extinguishers, they must be maintained at the business. The business enters into a contract with a fire extinguisher maintenance facility to perform the maintenance work on the fire extinguishers.

Fire extinguishers must undergo a preliminary inspection by the person responsible for fire safety at the facility before obtaining and deploying them at that facility.

They establish during the preliminary inspection that:

• the fire extinguishers have a certificate of compliance;

• the log is available for each fire extinguisher;

• the seals on the fire extinguishers have not been broken;

- the fire extinguishers do not have any visible exterior damage;

- the pressure indicator arrows of pump fire extinguishers are within the limits of the operating range (in the green sector of the indicator scale) depending on the temperature of the usage;

- the fire extinguisher's manufacturer and the maintenance facility having the right to perform its maintenance, the date of manufacture (sale) and the date maintenance was performed are on the marking of each fire extinguisher and indicated in its log.

A registration (inventory) number is assigned to the fire extinguishers at the facility in accordance with its adopted numbering scheme after the preliminary inspection.

The person responsible for fire safety at the facility must create a fire extinguisher account book at the facility.

The fire extinguishers must be deployed in easily accessible and visible locations, and also near locations where the fires are more likely to occur. At the same time, they must be protected from the sun, heaters and heating instruments, and also chemically aggressive substances (environments) which may have a negative influence on their functionality.

Portable fire extinguishers are deployed by hanging them using brackets on a vertical structure at a height not greater than 1.5 meters from the floor to the lower end of the fire extinguisher and at a distance from a door sufficient for its full opening or install them in the fire cabinets for fire cocks, on fire panels or benches, pedestals or special cabinets.

Deployment of fire extinguishers using brackets on vertical structures, their installation in fire cabinets or other cabinets must be done in such a way that provides for the ability to read the markings on their bodies.

Fire extinguishers must be deployed with respect to the convenience of their service, inspection and use and also the achievement of the best visibility from various points of the space being protected.

Approaches to deployment locations of fire extinguishers must always be free.

Direction signs must be installed to indicate the locations of fire extinguishers at the facilities:

Place the signs in visible places at a height of 2.0 – 2.5 meters from the floor both inside and outside the facilities.

In facilities where there is no permanent presence of workers, fire extinguishers must be deployed outside the facilities or at the entrance to them.

A periodic review of fire extinguishers is performed by the person responsible for fire safety at the facility not less frequently than one time a month.

Portable fire extinguishers contain a limited quantity of a fire suppression substance and, as a rule, a continuous flow occurs in a short time interval, whereby errors introduced during use cannot be corrected.

Below are cited the practical methods (in different situations) that must be observed in the use of the more widespread powder (1) and carbon dioxide (2) fire extinguishers:

1) Powder fire extinguishers are used for putting out class A, V, and S fires (the burning of solid, liquid and gaseous substances).

In putting out a class A fire (the burning of sold substances) the fire extinguisher powder must be delivered at the seat of the fire, moving the stream from side to side for the purpose of suppressing the flames. After the flame has been suppressed, it is necessary to get closer and cover the whole surface of the burning substance, and especially the individual spots, with a layer of powder, during which the powder is dispersed in intermittent portions.

During extinguishing of a class V fire (burning of liquids) at first deliver the stream of powder at the nearest edge, moving the nozzle from side to side to cover the whole width of the fire. The powder must be delivered without interruption with a fully open valve while moving forward and while not moving back and along the sides of the unsuppressed area while trying to maintain the cloud of powder in the burning area.

During extinguishing of a class S fire (burning of gaseous substances) the fire suppressant powder must first be aimed at the jet of gas almost parallel to the gas flow.

The fire suppressant stream must be aimed directly at the source of the flame during extinguishing of electrical equipment.

Cut off the power to the electrical equipment before starting to put it out.

Some recommendations for working with powder fire extinguishers are cited in figure 2.

Figure 2. Recommendations for the use of powder fire extinguishers

2) Carbon dioxide fire extinguishers are used, as a rule, for putting out a class V fire (burning of liquids) and electrical equipment (E)

During the extinguishing of a class V fire, the bell mouth must be aimed at the seat of the fire's base which is closest to the operator. The operator must make movements with the bell mouth from side to side during the extinguishing while moving forward. The tactic is the same when putting out electrical equipment using powder fire extinguishers.

Some common safety rules must be observed in the usage of all types of fire extinguishers:

• in the event of discovery of a fire, sound the alarm and notify the fire department;

• do not pass the fire looking for a fire extinguisher because a room with no exit can become a trap;

• in putting out live electrical equipment, the distance from the electrical equipment to the fire extinguisher nozzle (bell mouth) must not be less than 1 meter;

• extinguish it from the windward side;

• leave a free evacuation route (provide yourself the opportunity for escape);

• abandon the premises and await help in case of being unsuccessful in fighting the fire;

• when using several fire extinguishers to put out a fire do not allow the streams of fire suppressant to aimed at each other;

• after putting out the fire, it is necessary to back off while still facing it;

• when a reserve fire extinguisher with a fire suppressant that cools is available, treat the burned surfaces for the prevention of repeated combustion.

Fire alarms

Fire alarm systems are intended for revelation of a fire's initial stage, the transmission of reports about the place and time of its occurrence and, when necessary, the initialization of automatic fire suppressant systems.

Fire alarm systems are manual and automatic.

One turns on manual alarms by pushing a button. Automatic alarms are divided into heat, smoke, optical and combined systems.

Heat alarms operate when the temperature increases in the facility. They have a sensor – a thermistor, thermocouplers, coils, bimetallic plates or fusible inserts. Among them are alarms of the TRV, MDTI-028, DPS-038, IP2 / 1, POST types and others.

The sensor in smoke alarms is photoelectric cells (IDR-M) or ionized cells with radioactive sensors (RID-1, RID-6). Smoke enters the ionized cell, decreasing the ionization of the air and this causes activation of the signal (DIP-1, DIP-2, RID-1,RID-6M).

A photoelectric cell reacts to the infrared part of the flame spectrum in optical alarms. Among them are alarms of the DPID and AIP-M type.

Combination alarms have thermistors and an ionization cell (for example, the KI-1).

Administrative Procedures for Fire Safety

According Ukraine's law "On Fire Safety" fire and engineering commissions (PTK) are created at businesses who employ 50 and more people. Their work is organized according to "Standard Conditions for a Fire and Engineering Commission" affirmed by Ministry of Internal Affairs order Number 5 of 27 September 1994.

All manufacturing facilities, installations and building are divided into 5 categories:

A – explosion and fire dangerous. Such facilities use burning gases or highly inflammable liquids with a flash temperature up to 28 degrees Celsius in such a quantity that a burning mixture can be created with the air, during the burning (explosion) of which an excess pressure greater than 5 kilopascals is created in the facility;

B – explosion and fire dangerous. Such facilities use highly inflammable liquids with a flash temperature from 28 degrees Celsius to 61 degrees Celsius or combustible powders and fibers in such a quantity that a burning mixture can be created with the air, during the burning (explosion) of which a pressure greater than 5 kilopascals is created in the facility;

C – fire dangerous. In such facilities they use either combustible liquids (a flash point greater than 61 degrees Celsius) or solid combustible materials or powders and fibers (the lower concentration edge of flame propagation of their mixture with the air is above 65 degrees per cubic meter);

GID – fire-safe. There are no combustible substances and materials in such facilities.

Limitation of fire propagation between buildings is achieved:

• by placement of explosion and fire dangerous manufacturing and storage buildings, exterior installations, and flammable liquid and combustible gas storage facilities with respect to the direction of the prevailing winds and also terrain;

• by establishment of fire-prevention gaps between buildings and exterior installations and also open areas for storage of flammable substances and materials;

• by a decrease of the fire hazard of building materials used in enclosed structures, including trim and façade linings, and also in coverings;

• by use of design concepts directed at the creation of obstacles to the propagation of fire between buildings.

Fire breaks are installed depending on the significance, explosion and fire and fire danger category, and the degree of fire resistance of the buildings according to the requirements of Ukrainian National Construction Regulation (DBN) 360, Construction Standards and Regulations (SNiP) II-89, DBN B.2. 4-1, DBN B.2.4-3, SNiP 2.11.06, Industry-Specific Construction Standards (VSN) V.2.2-53 and other regulatory documentation.

Design concepts directed at the creation of a barrier to the propagation of a fire between buildings are the layout of fire walls, the limitation of the area of windows and other apertures in exterior walls and the use of fire-retardant glazing, window cuts and others.

The evacuation of people in case of a fire must be provided for by evacuation through emergency exits.

Parts of a building intended for different purposes separated by the first type of fire walls (fireproof modules) must be provided with their own evacuation routes.

Facilities which are divided temporarily by partitions that are being converted or fireproof curtains (screens) must have their own emergency exits from each section.

It is prohibited to place category A and B facilities directly above or below facilities intended for the simultaneous occupancy of more than 50 people.

Emergency exits and evacuation routes must be designated using fire safety signs in accordance with State Standard 12. 4.026.

Exits are for emergencies if they lead from the premises:

a) of a first floor – outside directly or through a corridor, vestibule (foyer) and staircase;

b) of any floor above ground, except for the first: through a corridor, hall, foyer to a staircase or type S3 stairs; directly to a staircase or type S3 stairs;

c) to a neighboring facility on the very same floor that is provided with exits;

d) of an entrance, basement or below-ground floor – directly outside through a staircase or through a corridor leading to a staircase having an exit directly outside or isolated from floors located above.

Not fewer than two emergency exits must be provided from a building, from every floor and from a facility, with the exception of cases determined by the armed forces.

One emergency exit can be provided for from:

a) a facility with the simultaneous occupancy of not more than 50 people if the distance from the most isolated point and floor to the marked exit does not exceed 25 meters;

b) a facility with an area of not more than 300 square meters located in a ground, basement or below-ground floor if the number of people permanently located in it does not exceed 5 people. Providing a second exit through a hatch measuring not less than 0.6 meters x 0.8 meters and with a vertical metal step ladder not less than 0.45 meters wide or through a window measuring not less than 0.75 meters x 1.5 meters or with attachments for an exit is allowed for a quantity of from 6 to 15 people. An exit through a cellar must be equipped with metal ladders (or brackets) in the cellar;

c) a ground, basement or below-ground floor with an area of not more than 300 square meters and intended for the simultaneous presence of not more than 5 people. An additional exit from a floor must be provided for a quantity of 6 to 15 people in accordance with subparagraph b) of this paragraph.

The laws, regulations and instructions presented above in toto are for all branches of the national economy.

Medical institutions are structured differently, but in general all have laboratories, pharmacies and pharmaceutical storage facilities. Presented below are the specific uniform requirements for fire safety.

Warehouse buildings for storage of chemical substances must be not lower than level II in fire resistance, and then the quantity of chemical substances in the warehouse cabinets must be in conformance for fire prevention and entered in the shop instructions on fire safety measures.

All work with chemical substance must be executed accurately so as not to damage their packaging. An inscription or tag with its name and guidance relative to the most characteristic attributes ("flammable," "poisonous," "chemically active," etc) must be on each container with a chemical substance.

Packaging and issuing chemical substances is not allowed in places for storage. This process is implemented only in special facilities.

Chemical substances need to be stored according to the principle of uniformity in accordance with their physical, chemical and flammable properties. Warehouses are separated into separate facilities (compartments) for this purpose that are isolated from each other by fire-preventing and fireproof partitions.

Solid and liquid chemical substances must be stored in closed, dry facilities or under a cover in a container corresponding to existing requirements, most of all technical nature and climatic conditions. Only those chemical substance that do not decompose, ignite or catch fire as a result of interacting with the ambient air are permitted to be stored under a cover.

The placement of instruments restricting the free flow of melted material (side boards, thresholds with ramps and the like) must be provided in facilities where substances capable of melting in a fire are stored).

Chemical substances, during the burning and decomposition of which toxic steams and gases are discharged, the processes of extinguishing and evacuation of

substances located in the facility are complicated and for which different means of fire suppression are used must be stored in isolation from each other.

Sacks, drums, barrels and other containers with chemical substances arriving at a warehouse must be stored on shelves or in stacks made from fireproof materials, be in a serviceable state and must not be of excessive weight. Storing chemical substance near heaters is not allowed. Shelves and stacks must be not less than 1 meter from heaters.

Warehouses for substances that react rapidly with water (carbides, alkaline metals, hydrate of sodium and others), and also compositions for powder and pulverized polymers, carbon-black, and graphite must be located in dry single-story facilities, well ventilated and with a cover that can be removed easily. No water, steam or sewer pipes can be placed inside these facilities. The covers and walls must not admit rainfall and the foundation must be protected from ground water.

Metal powders able to ignite spontaneously (aluminum, zinc, magnesium and phosphorous) must be stored in separate compartments in a hermitically sealed container. In case of the storage of nitric and sulphuric acids, measures must be adopted to prevent their coming into contact with wood, straw, organic substances and the like. Pouring concentrated nitric acid into glass bottles is prohibited. Prepared chalk, lime or soda solutions must be available for the immediate neutralization of acids spilled by accident in warehouses and beneath covers.

Alkaline metals must be stored in isolated compartments (sections), at the end of a warehouse in metal cans or containers beneath a layer of a protective medium (inert gas, mineral oil, kerosene or paraffin). When storing different alkaline metals in the same section of a warehouse, each of them must be located on a separate shelf. Only non-flammable chemical substances are permitted to be stored in compartments adjacent to alkaline metal compartments.

Only transport in good working order and equipped with fire-fighting equipment and neutralization substances can be used to carry chemical substances in a container. It is forbidden to leave the vehicle used for loading and unloading on the grounds of the warehouses after finishing the work.

Do not allow damage to the container, its fall from any height or spreading of the substance by spilling the liquid during loading and unloading. The loading and unloading mechanism used during the loading and unloading work must be in operating order.

Electrical equipment must be shut off in all warehouses after finishing the work.

It is forbidden:

• to perform work in warehouses not connected with the storage of chemical substances;

• to allow personnel in damp (moist) clothing and footwear into storage facilities where chemical substances are stored that react with water;

• to use corks from organic materials (wood, fabrics, straw, etc.) for closing bottles with acid.

Potential causes for the outbreak of a fire in laboratories that are an integral component of businesses of the pharmaceutical industry can be:

• violation of the storage and usage regulations and standards of highly inflammable and combustible substances;

• violation of the regulations in performing welding and flammable operations;

• violation of the usage regulations for heating and ventilation instruments and systems;

• smoking.

Therefore, laboratory employees must possess the foundation for assuring fire safety when using the chemical substances and materials being used and adhere to safety measures when working with them.

Thus, the storage in laboratories of substances and materials must be carried out only according to type. The combined storage of substances, the chemical interaction of which may cause the ignition of a fire or an explosion, is not allowed.

The total stock of highly inflammable substances and alkaline metals stored simultaneously in each workplace must not exceed the daily need. Vessels in which work with them has been performed must be treated with fire-retardant solutions after finishing the work.

7. Recommended Literature

Primary:

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Additional:

1. Ukrainian Law "On Fire Safety". Herald of the Supreme Council. 1994, Number 68.

2. Ukrainian Law "On Labor Protection" (new edition of January 1, 2004), articles 6, 8, 18, 21.

3. Ukrainian Ministry of Education and Science, Ministry of Internal Affairs and the State Fire Inspection Main Directorate decree Number 348/70 of September 30, 1998, "On the Affirmation of the Fire Safety Regulations for Institutions, Establishments and Organization of Ukraine's Education System."

4. Decree of the Ukrainian Ministry of Health Number 44 of March 16, 1993, "On the Organization of the Storage in Pharmaceutical Establishments of Different Groups of Drugs and Medical Articles."

5. Fire Safety Regulations for Businesses Manufacturing Drugs (NAPB-V 01.051-99/191). Kiev, 2001, 175 pages.